amateur radio

SEPTEMBER, 1974

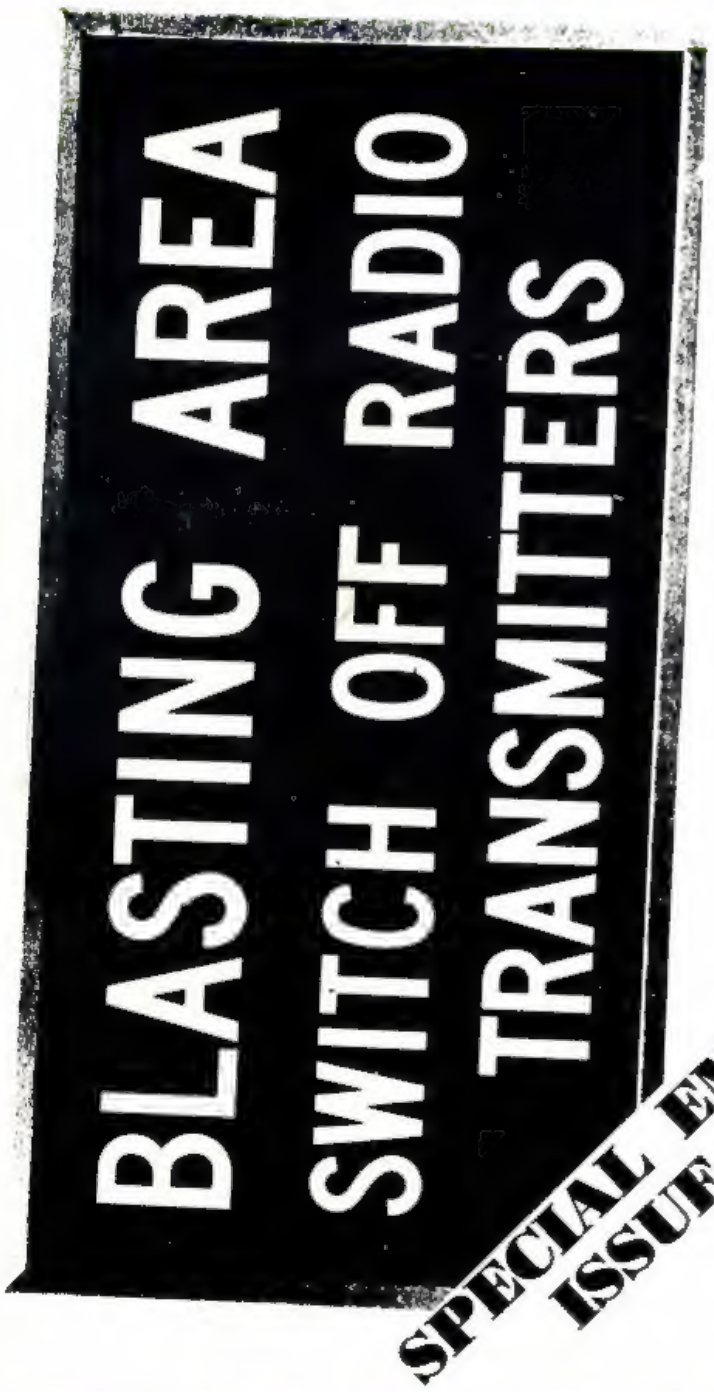

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PHOTO
Sign evidence of a common EMC problem.

JOURNAL OF THE WIRELESS INSTITUTE OF AUSTRALIA

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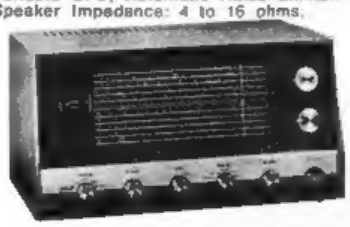

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amateur radio

JOURNAL OF THE WIRELESS INSTITUTE OF AUSTRALIA, FOUNDED 1910

SEPTEMBER, 1974
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QSP

Electromagnetic Compatibility Electromagnetic Interference

It is doubtful if anyone fully comprehends the full impact on modern society or the interactions of all the technical, economic, social and political complexities resulting from the electromagnetic spectrum.

What is this electromagnetic spectrum? About one-half of all our telecommunications between fixed points, all radio and TV broadcasting, mobile communications, radar and radionavigation services are transmitted by radiation at various frequencies of the electromagnetic spectrum. It is a national resource which costs nothing to use and yet its value at any given time can be drastically reduced by misuse. It is a resource which must be shared nationally and internationally and is absolutely irreplaceable in our present way of life.

Although the electromagnetic spectrum theoretically stretches through many decades of frequency, it is, unfortunately, a limited resource since only a microscopic part can be utilized within the bounds of today's technical know-how. About 80 per cent of the present uses of the spectrum have come about since World War 2.

In short, we are running out of usable spectrum and the proper management of it is of extreme importance.

Part of this management centres around control of equipment design in aspects of Electromagnetic Interference and Electromagnetic Compatibility.

Electromagnetic Interference (EMI) may be defined as causing a degradation in performance of an equipment as a result of its susceptibility to internally generated interference or external fields and voltages generated by other causes. Thus an equipment may be either Radiation Susceptible (RS) or Conduction Susceptible (CS), or it may cause interference in which case the emission may be Conducted Emission (CE) or Radiation Emission (RE).

Electromagnetic Compatibility (EMC) may be defined as the ability of equipments to function without degrading the performance of other equipments by EMI. The two terms EMI and EMC clearly therefore should not be regarded as separate problems but rather as interdependent.

Equipment subject to EMI and EMC may be classified as:

a. Communication-Electronic (C-E) equipment which includes:
   (1) Receivers using antennas;
   (2) Transmitters using antennas; and
   (3) Non-antenna C-E equipment (such as counters and test equipment).
b. Non-Communication Equipment which includes:
   (1) Non C-E equipment in which RF energy is intentionally generated for other than information or control (such as ultrasonic equipment, medical diathermy equipment and uninterruptible power supplies);
   (2) Electrical equipment such as electric motors in all types of appliances; and
   (3) Accessories for engines and vehicles such as alternators, gauges and windscreen wipers.
c. Vehicles and engine driven equipment.
d. Overhead power lines.

EMI is a form of pollution as serious and widespread as other forms. Its presence is apparent in many ways and its seriousness has long been recognised. It has two main causes. The first is unacceptable radiation or conduction at other than the required frequency by electronic equipment such as communications transmitters and radar sets. The second is wide-band random emission by all types of electrical and electronic devices.

The level of EMI/EMC design knowledge in Australia is generally low by overseas standards and being, as it is, as much an art as a science, considerable experience is required before personnel become proficient in this field.

Here then is another challenge for the amateur.

John McL. Bennett, VK3ZA

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The items on this page are but a few from our large and still growing range of accessories. If the accessory you require is not shown on this page then call us or our agents, we're sure to have it.

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PRICE CORRECTION

The price of the **YAESU MODEL 620** in the Insert last month should be **$368.** Please alter your copy.

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QSP

The signal reproduced here speaks for itself, and no doubt those WICEN operators who listened for the Quest will be pleased to know that their efforts were officially appreciated. Although the vessel was found eventually not to have been in distress, apart from a battering by heavy weather, the exercise served to point up some of the strengths and weaknesses of the present WICEN organisation.

When Quest failed to meet her sked on ship-shore frequencies, and the Marine Operations Centre was advised that she had amateur radio gear on board and might call for help on 14 MHz, the centre had no formal procedure for requesting a listening watch by amateur operators. It happened that the officer on duty was a retired Commander, RAN, personally acquainted with VK3CDR and aware that the latter is still a serving naval officer and accessible through the Defence communications system; it was also fortuitous that VK3CDR is a member of WIA Executive and was in a position to alert eastern States' WICEN networks with minimum delay.

In this rather minor call-out, the "Old Boy" net operated more effectively than such official arrangements as exist. This in itself is no bad thing; the one great advantage WICEN has over professional emergency services is the way our hobby permeates the whole community, so that amateur radio operators can be found in almost any organisation or walk of life. Nevertheless there is a demonstrable need to maintain an effective formal framework and to improve liaison with other emergency instrumentalities, especially in the Federal area.

A successful approach has already been made to the Director General of the National Disasters Organisation, and Executive is now reviewing the Federal structure of WICEN. As our strength lies in local community effort there is no intention on the part of Executive to interfere in the internal affairs of State networks; however it is palpably necessary to re-activate the position of Federal WICEN co-ordinator, and to define lines of communication with and between Divisional co-ordinators.

Jim Lloyd, VK3CDR

ROUTINE 270113Z JUL 74
FROM MARINE OPERATIONS CANBERRA
TO DEFNAV CANBERRA
BT
UNCLAS
FOR SURGEON CAPTAIN LLOYD,
MELBOURNE.
1. NEW ZEALAND VESSEL WAIKARE/ZMCT REPORTED SIGHTING QUEST AT 262100Z IN POSN 3446S 17024E COURSE APPROX 080 TRUE UNDER STEAM AND SAIL.
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3. IT IS REQUESED THAT YOU PASS ON TO ALL CONCERNED OUR THANKS FOR THEIR CO-OPERATION.
BT
END UNCLASSIFIED
ACTION MIDS

JOTA 1974

Please do not forget the 17th Jamboree on the Air on 19th/20th October 1974. It begins at 00.01 Local Time on Saturday 19th and terminates 48 hours later, but stations can operate from the Friday evening if more convenient.

TREES AS AERIALS

The Editorial in Ham Radio for May '74 gives brief details of US Army researches into the use of trees, light standards and other objects as antennae through the use of a flexible, toroid-shaped hybrid electromagnetic antenna coupler called a Hamac which is formed in a circle around the tree. "A 100-foot tree, for example, works best in the 80 metre range. Who will be the first to put this idea to work on Field Day?"

USA NOVICE LICENCE EXAM

"When the amateur Novice licence was first issued over 20 years ago, almost any applicant with no previous electronic knowledge could pass its written examination after reading the questions and answers in Novice study guide a few times without understanding anything he memorised. But not today! Today, trying to pass the Novice written exam simply by studying the questions and answers of the appropriate study guide is doomed to failure on at least the first or second attempt, unless the student already has a pretty good electronic background. The difficulty is that the study guides supply the facts upon which the examinations are based, they do not supply the explanations necessary to understand the facts". From Novice Shack in CQ May '74. Another snippet from the same column reads "The good news is that there is still no fee for the Novice licence" (the basic amateur licence fee was quoted as $10.00 and the CB licence fee is $25.00).

WHAT IS AMATEUR RADIO?

"What Fred Laun's (LU5HFI, ex HSSAL etc.) Kidnappers (in Argentina) may have perceived as a threat to them, was in fact a hobby used by thousands of men, women and children around the world as a means of promoting friendship and understanding. To the terrorists (who) kidnapped him all of this (amateur gear) may have been seen as some sort of clandestine operation designed to pass along information about their guerilla operations." Quotes from a quote in Zero Bias CQ May '74.

NEW CALL SIGN PREFIXES

Radio Communication June '74 carries the information that the ITU have provisionally allocated call-sign series as follows — Bahrain A9A—A9Z and Cyprus (Republic) C4A—C4Z.

"CITIZENS BAND"

"The president of the United CBers of America has been jailed for 18 months and the UCBA fined $5000 following conviction on 11 counts of violation of FCC rules and other illegal activities." Radio Communications June '74.

INVENTIONS

Pat Hawker, G3VA, in his TT column Radio Communications June '74, quotes from his reading a booklet "Understanding creativity — a lightning course for executives" by Jack Nickle Smith: "He points out that if you suggested that inventive genius is a combination of intense concentration and pure logic many people would believe you. In practice it is more often the exact opposite. Logic sticks to the rules and inhibits new ideas. This is not to say that orthodox minds are not necessary to society. But innovation is finding a new, creative solution to a problem; not all problems require such solutions, some can be solved logically but these are not the really great innovations . . . . Rather than "an infinite capacity for taking pains" a genius has "an infinite capacity for curiosity and daring thought". Innovators need comprehensive knowledge of their subjects, but not disciplined knowledge."

IARU PRESIDENT

"ARRL Vice-President Noel B. Eaton, VE3CJ, was formally elected president of the IARU — the seventh since the Union was organised at Paris 49 years ago". QST June '74.

TABLE OF FREQUENCY ALLOCATIONS 10 kHz to 275 GHz

A new booklet is now available from the Radio Branches of the PMG's Department which lists all the Australian allocations for the entire usable spectrum. It is a very comprehensive publication and will assuredly interest all those who may need reference material on this subject. The price is 50c (better add 15c for postage) and the WIA copy was obtained from Central Office.

Shortly after Mrs. Whitlam opened the Townsville Pacific Festival she inspected the TARC display. Eventually she took the microphone and spoke to several VK3 stations.

Electronic Pollution - an impending crisis

By WEBB GARRISON
Reproduced from Popular Electronics, April 1973

AN ENVIRONMENTAL FACTOR THAT IS OFTEN OVERLOOKED

"The electromagnetic spectrum is one of our major natural resources. For decades, we have been taking it for granted. We can no longer afford the luxury of such an attitude; there must be a clean-up in spectrum pollution." Environmentalists who did not fully understand what he meant applauded the 1968 address in which FCC Commissioner Robert E. Lee made his plea. Engineers who did understand him agreed that the EM spectrum deserves to be ranked with air, water, and other resources. Most experts, however, took a dim view of the possibilities of a quick clean-up even in the limited part of the spectrum that includes the r-f band.

Today, matters are far worse than they were in 1968. Unexpected effects are becoming increasingly common:

- En route from Miami to San Francisco, a jetliner's navigational system suddenly indicated that the plane was headed for Mexico City.
- A banker wearing an implanted cardiac pacemaker nearly died when he stood close to a commercial microwave oven, and a woman using a similar device was thrown into cardiac crisis by diathermy equipment near her hospital room.
- A Colorado businessman (who should have known better) used properly functioning equipment operating on a licensed frequency to call his office by radio from a construction zone: three members of a work crew narrowly escaped death in the blast and rock slide he triggered.
- Radar systems of a major airport went haywire due to uncontrollable disturbances. The trouble began on Christmas Day. "Now we've learned to expect an annual battle with interference from toy walkie-talkies. Thank God those things break after a few weeks", said an FCC engineer.
- Memory banks of a big Louisiana computer system were crippled when stored information was suddenly erased by radar from a nearby airport.

And so the list goes on and on, pointing up a rapid growth and continued increase in a form of pollution environmentalists often do not even cite. In the U.S. alone, the FCC receives about 1000 complaints per week about interference. Worldwide, the electromagnetic spectrum is becoming unbearably crowded. Simultaneously, proliferation of highly sophisticated electronic devices is multiplying the probability of your receiving unwanted inputs.

The 1971 international symposium of the Institute of Electrical and Electronics Engineers that was held in Philadelphia zeroed in on this problem. Robert D. Goldblum, a supervising engineer at General Electric's Re-entry and Environmental Systems Division, spoke for 500 scientists and engineers from seven nations when he said: "With thousands of radio, television, and radar transmitters throughout the world beaming electromagnetic radiation through the air almost constantly, we are literally polluting the electromagnetic spectrum".

NOISE

During the early days of radio and telephone communication, acoustic filters were numerous and troublesome. It was natural to call such disturbances "noise", and to extend the label to cover electric waves that produced them. Today, interfering waveforms that do not have audible output are encountered in many systems. But "noise" remains the most common name for any kind of interference.

Much noise in a communication system is internal. Some is thermal. Other effects stem from electrons travelling from a heated cathode toward an anode. Such noise is of vital importance in communication, but pollution of the EM spectrum stems from noise caused by radiation external to the systems affected. Much of it is due to natural processes. But man's additons are constantly growing.

International Q signals used to describe r-f interference label nature's noise QRN. At first considered to be rather simple in nature, QRN is now known to be enormously complex. Beyond both ends of the radio band, waves create effects unknown to early radio pioneers.

Atmospheric static is believed to be linked with electrical discharges that take place between water droplets during turbulence. It is especially strong in the AM broadcast band but also affects the VHF band used for TV and FM. Current tests indicate that rainstorms produce broadband noise that extends deep into the microwave region.

Solar flares sometimes cause widespread disruption of radio service. But many faint signals that reach our planet come from more distant sources. Cosmic rays, X-rays from galactic sources, and infrared light shower down on us from every part of the universe.

Radio astronomy was born as a result of studies aimed at reducing noise in telephone conversations sent across the Atlantic by radio. Karl Guthe Jansky of Bell Telephone Laboratories hooked up a 100-ft antenna to study noise. One night in 1932, he picked up a new sound that was somewhat like a faint hissing. Eventually, he identified the source — it came from the stars. Since then, it has been discovered that various types of celestial bodies emit so many different kinds of radiation that most or all of the EM spectrum is affected.

MAN'S CONTRIBUTIONS

QRM — man-made electrical noise — is often called "grass" by radar operators. TV engineers complain about "birdies" and "glitch". Along with a bevy of other man-made effects, these constitute electromagnetic junk.

Motors were the first devices to yield radiant trash. Today, a multitude of household and industrial appliances, from electric shavers to arc welders, produce radiant energy as side effects of their operation.

Medical equipment got into the act at least as early as 1905, a decade after Roentgen discovered X-rays. Abundance of X-ray, diathermy, and other machines causes a modern hospital to literally pulsate with radiant energy. Most of it does no harm, but any day, any burst of radiation can create emergency-level noise h it happens to fall upon a system capable of receiving it.

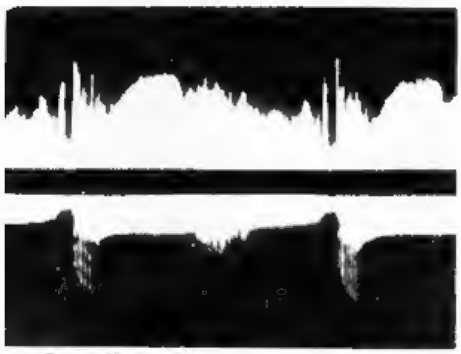
Communication would return to the era of the carrier pigeon if we suddenly stopped using enormous quantities of radiant energy to convey signals. But the proliferation of radio transmitters is a major factor in the production of electronic pollution. In 1949, there were 160,000 transmitters operating in the U.S.; today, there are 36 times as many.

No one knows what happens to individuals whose electrical processes are affected by radio and TV transmission. But Britain's respected journal **New Scientist** has pointed out that a 1.25-megawatt station dispenses so much radiant energy that the daily bombardment one mile away is sufficient to lift the family car 2 ft off the ground. Irrelevant? Not according to growing evidence. Quotes **New Scientist**, "There is some connection between chronic exposure to certain radio frequencies and a wide range of physical and

mental disorders".

About all we know positively is that some human organs are more susceptible to radiation damage than are others. "Practically speaking", points out Robert Goldblum in the 1970 edition of **ITEM**, "the human body is a three-dimensional mass having width and depth, as well as height. Therefore, when a man stands erect in an r-f field, he represents an object whose height, width, and depth dimensions can be expressed in terms of wavelength. When the body is so oriented that any of these major dimensions is parallel to the plane of polarisation of the r-f energy, the effects are likely to be more pronounced than when the body is oriented to other positions."

Transportation is more obscure than communication in its role as an EM pollutant, but it is highly important because whenever a spark occurs, a radio signal is generated. Many ignition systems radiate staccato-like bursts of noise over a broad range of the r-f band. Radar, now vital to forms of transportation ranging from measurement of highway speeds to observation of aircraft, emits its own kind of radiant energy at constantly increasing levels.



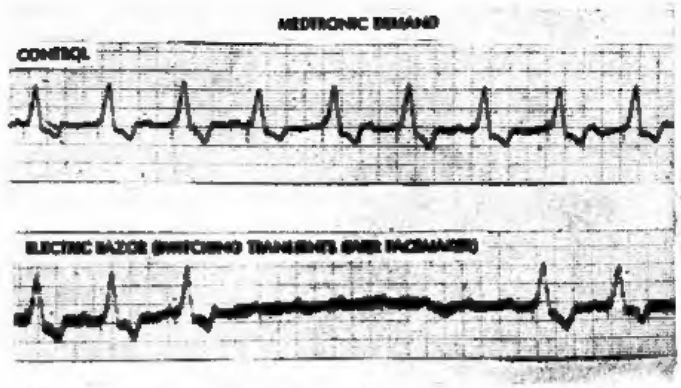
Power-line noise present on visual carrier (TV). (Photo courtesy IEEE)

MAN'S FURTHER CONTRIBUTIONS

Lights of various kinds emit enough radiation outside the wavelength of visible light to be considered serious pollutants. Few ordinary sources of electronic noise give TV receivers more trouble than does a flickering fluorescent tube. Neon advertising signs and other signs that use gases can create a virtual EM blackout for hundreds of yards in every direction.

Nuclear blasts at high altitudes yield radiant energy that interferes with some radar frequencies. Called the "Argus Effect" because it is reminiscent of the Greek creature with 100 eyes, it is being studied as a possible technique for rendering blind enemy radar. And electronic countermeasure (ECM) devices are constantly being developed, adding to the pollution problem.

Microwaves, first put to practical use in World War II radar installations, offer some hope, plus new dangers. Today, microwave relay towers dot the countryside of every advanced nation. With at least 50,000 general-purpose computers operating in the U.S., it is inevitable that microwave transmission of data will show a dramatic increase within this decade. But microwaves are not limited to the field of communication. They do everything from curing plastics and lumber to warming and cooking food. Relatively innocent as sources of noise during the early years of use, microwaves have now been indicted on many counts.

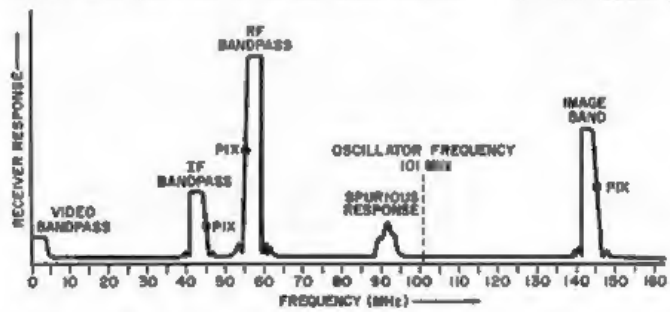


Curve traces show how interference from electric razor affected pacemaker. ("British Heart Journal")

TV DETECTIVE

More than any other common electronic device, TV receivers reveal pollution. Much of this noise stems from too strong signals. Such interference is a nuisance, but it is not a hazard. However, it points up the complexity of the problem.

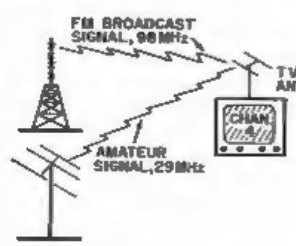
Practically all common sources of EM radiation produce characteristic and readily identifiable patterns of visual disturbance.



TV receiver tuned to channel 2 (54 to 60 MHz) has potential for picking up noise from four additional bands of frequencies. (Photo: RCA "Consumer Electronics & Commercial Systems")

Mild r-f interference creates a cross-hatched or basket-weave pattern. Diathermy creates moving ripples, herringbones, and similar effects. Power-line noises that can originate at any or all of five sources in normal cable suspension hardware creates pulses that can stop any show. Spark plug interference, usually random, causes fleeting but conspicuous spots. Boats and motorcycles cause much more trouble than do cars since their plugs are less heavily shielded.

Transmitters often radiate energy of several different frequencies with receivers that can frequently pick up two or more frequencies. This factor, coupled with the multiplicity of external sources of noise, makes the chart of sources of TVI too complicated for beginners to read. Every time a TV receiver reveals interference, it can be taken for granted that dozens or hundreds of unseen events are occurring simultaneously. Electromagnetic interference is usually intermittent in a given case. But at any instant, it is taking place wherever electronic devices are being used.



Two signals add or subtract to equal frequency of TV channel (98—29=69).

AN UPHILL BATTLE

In the war against electronic pollution, progress is being made. But EM interference sits on the shoulders of the electronic age like the Old Man of the Sea on the back of Sinbad the Sailor. With each forward step, the burden becomes heavier.

Upgrading specifications for colour TV receivers has about eliminated excessive X-rays — from properly functioning equipment. Tighter control over manufacturing standards has produced microwave ovens that pose no threat to wearers of cardiac pacemakers — providing that the door seals of the ovens remain factory-fresh.

Passengers on jet airliners are no longer permitted to operate FM radio receivers during flight; they can wreak havoc on navigational equipment. Radio-controlled model airplanes have been outlawed in many cities for obvious and not-so-obvious reasons; one manufacturer, Champion, has spent a fortune developing a resistor spark plug that minimises noise. Too, the FCC is making a real effort to crack down on broadcasters who do not adhere to assigned frequencies.

Meanwhile, the tide of pollution mounts. Gains are more often than not offset by the continuing upsurge in the number and kinds of equipment transmitting or receiv-

ing r-f and microwaves. Deliberate jamming is a growing international problem, as is radio and TV piracy.

Most domestic interference is unintentional, but it may occur whenever the right conditions are found. Every increase in radiated EM energy has potential for creating new problems.

Largely unexplored biological effects of EM radiaton are so vast that in some circles there is serious talk of trying to leadshield homes and offices close to powerful transmitters. With the microwave communications industry already billed as the "next big glamour field on the investment horizon", there is little doubt that radiation will increase faster than protective measures can be taken and applied.

Interference now pollutes the spectrum so badly that the man on the street faces an impending global crisis. There is no real hope that interference can be eliminated. The best we can do is try to keep it at tolerable levels. ●

TV Interference from HF stations

R. S. GURR, VK5RG/T
9 Richmond Avenue, Daw Park, 5041

Standard TV aerial installation techniques utilise balanced feed systems, and care is taken to twist the feedline as it runs down a tower on standoff insulators. It is difficult to see how such a well balanced system would pick up even a little HF energy. The balance condition however is often destroyed at the TV tuner, where there may be unbalance introduced. The capacity from each 300 ohm tuner terminal to ground for instance is not always equal.

The unbalance introduced helps put large HF voltages (nearby Police, Amateur, Flying Doctor and Bushfire Nets) including spark plug ignition noises, at the tuner thereby causing overload — intermodulation conditions to be established.

We can overcome these conditions often with the connection of a three or four turn coil of wire across the TV aerial terminals, whereby the HF signals are shorted out, leaving the VHF relatively unattenuated. Unbalance could still prevail, however.

The idea of isolating the balanced feedline from the unbalanced TV receiver was first tried with 300 ohm to 75 ohm baluns used back to back. The effect was so noticeable, that the need for a High Pass filter became redundant. Ignition noise reduction was the most beneficial property of this method, due to the elimination of the high level HF components in the feedline.

Cost of commercial baluns for this technique made it desirable to find a suitable alternative, and the practical way appeared to be to use one balun if possible. The simple means was of course the obvious — use a 1 to 1 isolation transformer — one whose losses were great at HF but low at VHF.

A Neosid Two hole ferrite TV balun core (**such as sold by the Components Division of the WIA.—Ed.**) is wound with two turns primary and two turns secondery of 10/0.0076 plastic hook up wire, with short tails left for connection to receiver and aerial. The result is so successful, even HF ham interference to a TV receiver using an indoor helical aerial is cured.

When I first made one of these for my own TV set, I was able to remove a 20 db resistive attenuator and a high pass filter that were used to overcome interference 10 years ago. ●

Diplomacy for amateurs

R. S. GURR, VK5RG/T
9 Richmond Avenue, Daw Park, 5041

No candidate at an A.O.C.P. or A.O.L.C.P. exam is asked to demonstrate his manners, temperament or tolerance. He is not questioned on his knowledge of the latest profanities — it is apparently assumed by the examiners, that he, being human, is psychologically suitable to have a licence.

Little surprise to anyone, when, one evening whilst working a new rare one, a previously unknown neighbour knocks, and suggests he **get off the so and so air.** Our 100 per cent mature diplomat will of course reply, "Yes mate, I will and may even volunteer to fix the problem!"

Most hams today are happy enough to keep up with the technology of their own rigs, and are entering new fields when they undertake to look at a neighbour's TV, Radio or Record Player. In 99 per cent of cases, touch that set, and you are on for a free service contract for life!

A recommended way to respond to a neighbour is, **"Yes, I will get off the air; however, I would like to continue to use my equipment tomorrow. Do you have any objection to my calling in a PMG Radio Inspector to do some tests".** With a reply like that to indicate he has won his point, neighbour invariably says, **"Yes".** Following this an exchange of names, nature of trouble, etc., can be made. **NEVER** admit liability or fault. The ham should now watch TV, read a book or play with the kids for the rest of the night. The following day call in a Radio Inspector for an early opinion on the problem.

If your rig is crook, you ought to hang your head in shame, fix it and shut up about it. If it is not, and the trouble is the other fellow's receiver, let the PMG Inspector break the news to him. If it is caused by outside influences, this is also not your responsibility unless the rusty joints, etc. are on your property.

Can you imagine the unfriendly atmosphere you will create if it is you, yourself, who condemns the complainant's equipment — you do not even want to see it — you could not care less whether it is the latest from Japan and uses 6 speakers instead of 2. Why should you have someone else's hobby suddenly thrust at you, and be forced to take any interest at all?

The WIA recommendation is, be pleasant, conduct tests when required by the Radio Inspector, and refrain from antagonising anyone. However, do not establish any undesirable precedents by actually repairing or modifying equipment yourself. Record carefully the days you remain off the air by official direction, so you may seek a reimbursement on your licence fee, if tests prove you were innocent of any breach of licence conditions. ●

Amateur transmitter interference

to tape recorders, record players, electronic organs, etc.

IVOR MORGAN, VK3DH
29 Constance Street, East Hawthorn, 3123

This is a report on a considerable amount of work carried out by Bert Hanson, VK3BAW and the writer. The work is by no means complete as yet but it is considered necessary to supply at least a report in the form of notes only, on the progress.

Introduction in the form of history or lead up to the subject should be quite superfluous so I propose to go directly into the problem.

I have had low level audio frequency valve amplifiers for microphone, record players and later tape decks, but any RF interference resulting in CW clicks clear voice or unresolved SSB, coming from the loud speaker system, can easily be cured.

Since these systems were invariably high impedance low level, design demanded careful shielding to eliminate hum frequencies from nearby mains and power supplies. The shielding also helped considerably to reduce RF detection and all one had to do was to include a resistor of 50 to 100K ohms in the grid lead of the first stage to form, with the capacity of the grid to earth, an integrating circuit. We then no longer had a radio frequency detector in the front end of the amplifier.

Since the introduction of the transistor, two things happened. One, the circuit is so low in general impedance that what we used to call "grid hum" pickup, no longer applies Second, designers found that shielding was no longer called for.

A smart character once said that "a transistor can do anything a valve can do". This is the understatement of the year. He forgot to add that in addition to the fundamentals that they can both "Oscillate, Rectify, and Amplify", the transistor amplifier is intrinsically wider in pass-band and more readily overloaded and made to detect in a non-linear manner.

Because of these factors, you will have observed that the manufacturers of record players no longer bother to shield the printed circuit boards. With a dynamic cartridge there will be six cascade stages over two printed circuit boards. Four stages including the complementary pair power output stage are usually on one board and a two stage high gain pre-amplifier/equaliser on another board. Neither of these PCBs are shielded as a rule and they are usually fitted to the cabinet in such a way that effective shielding is impossible.

Tape recorders are often not as bad in this respect as more metal shielding seems to be used. Microphone amplifiers vary a great deal but most of them would suffer interference in the strong RF field of a transmitter.

The manufacturers have stated that the percentage of cases where a very expensive record player or electronic organ etc. will suffer from RF interference is small This is all very well, but I would like to suggest that if a high gain AF amplifier of considerable power was designed to be immune from RF interference, the buying public would certainly appreciate it. The very expensive speaker cones would not be subjected to a damaging pulse every time the refrigerator starts up or a light is switched, and interference from dozens of other normal electrical appliances would similarly be silenced. The taxi car-phone in your street can also often completely ruin a recording you may be copying or listening to.

Commencing at the beginning, we found that a mains filter should be used. This helps considerably to reduce the spark transmitters referred to in the last paragraph. A simple filter consists of a ferrite toroid in the mains lead to the amplifier power supply. We removed the plug and wound as many turns as possible through a ferrite toroid 1½ inches outside diameter using the original flex lead to the amplifier. Much smaller ferrite toroids were used in pickup leads to the pre-amplifier. Medium sized toroids were used in the speaker leads at the amplifier end of these twin leads. Given a large enough ferrite toroid, both left and right hand speaker leads of a stereo system can be wound on one core since the speaker currents cancel in the toroid but the antenna effect of the speaker leads looks into a considerable inductive impedance, isolating the speaker leads from feeding RF into the amplifier.

Shielding speaker leads is useless, since they are almost always unbalanced and a voltage is introduced on the "hot" side, regardless.

Most commercial amplifiers we found, will not tolerate any capacity shunting the speaker leads as it directly affects the negative feed back loop to the early stage of the main amplifier.

So you cannot put capacitors across the speaker leads nor shield them, nor can you increase resistance as the voice coil is usually 8 ohms and any extra resistance will degrade the amplifier. Hence the ferrite toroids using, if possible, the existing speaker leads with no increase in resistance or capacity.

We have found that a small ferrite bead (No. 3, up to 28 MHz or No. 4 above), wound with as many as possible turns of 26 gauge enamelled wire, connected as close as possible to the base and in series with the base lead of the pickup input amplifier then followed by a capacitor of 100 pF from base to emitter and a 0.1 microfarad from emitter to earth, works best. If the latter is not possible due to negative feed back at the emitter point, 100 pF from collector to base may be used.

If having used a mains filter, speaker leads toroids, input leads toroids, amplifier input RF choke and by-passes, the system is not free from RF interference, at least it should be much improved.

I believe the amateur should try mains filter and speaker leads ferrite toroids first, if he is "treating" his near neighbour's record player or whatever, for the simple reason that it alone could be effective. You know as well as I do how you could be expected to service "for life" your neighbour's record player if you inserted a choke in the front end with a SOLDERING IRON!

In some cases I believe the only way to immunise the amplifier would be to build a new one in cast metal boxes with lids and all incoming and outgoing leads carried via feed through capacitors. The amateur must not be expected to do this.

Let us hope that very soon legislation will be drawn up which will develop Electro Magnetic Compatibility between the consumer, the amateur and the legislators. It is urgent that practical implementation of legislation for the protection of both amateur and consumer be made

In the main, it is clear that standards of performance to be expected by consumers of amplifiers must be defined. Manufacturers will have to meet these standards. The technical aspects of amateur equipment and radiations will be defined and standards set.

A qualified technical arbitrator will be necessary, one who is fully informed as to what standards are reached by the amplifiers and the amateur equipment, either home made or of commercial manufacture.

Finally irrespective of what conciliatory body is nominated, any decision made must be legally binding on both parties.

Particularly the amateur must be freed from the stigma of potential civil action, as for instance, "a public nuisance". ●

EMP - the ultimate EMC problem

JIM LLOYD, VK3CDR
Surgeon Captain S. J. Lloyd, QHS, RAN,
100 Wimbourne Ave., Mt. Eliza, 3930

WICEN operators! — will your Carphone withstand an input pulse of several thousand volts per metre with a rise-time measured in nanoseconds? If not, you will be of little help to your State Disaster Organisation in the event of a [illegible].

EMP — the Electromagnetic Pulse generated by the explosion of a nuclear weapon — is now being taken very seriously by designers of military communications and electronic equipment. It was given scant consideration in the early years of nuclear weapon testing, for example in the Monte Bello Islands and at Maralinga in the 1950s, because the electronic instrumentation was almost exclusively based on valves, which are relatively resistant to transient pulse damage.

The advent of solid-state techniques, although bringing so many other advantages as to become ubiquitous and inevitable, introduced a degree of vulnerability into the nuclear scenario that has only recently been fully appreciated. Semiconductor devices, as well as having low tolerance to high-voltage transients, are susceptible to nuclear radiation damage, and the concept of "nuclear hardening" is well established; that is, designing the apparatus to withstand at least as much radiation as would incapacitate its human operator.

This concept is hard to apply to EMP however, as the pulse is lethal to equipment far beyond the range at which human casualties would be caused by any of the effects of a nuclear weapon. In fact the electromagnetic pulse is not any hazard at all to personnel, except perhaps indirectly if you happen to be wearing an implanted cardiac pacemaker (and it won't do your transistorised hearing-aid any good!)

GENERATION OF THE ELECTROMAGNETIC PULSE

A nuclear explosion liberates a vast amount of energy, part of which appears in the form of gamma rays. If the explosion takes place in the atmosphere, many of the gamma photons interact with atoms of the air, in a number of ways of which the "Compton Effect" is most significant for the production of EMP. In this interaction, the collision of a photon with an orbital electron transfers energy from the photon to the electron, imparting additional momentum to the latter and causing it to recoil. The resultant movement of electrons constitutes an electric current and consequently induces a magnetic field.

If the system is balanced, the motion of electrons is uniform in all directions radially from the site of the explosion, the resultant magnetic fields cancel, and no pulse results. In practice, however, a degree of asymmetry is always present. This is introduced either by the proximity of the ground in a surface or low atmospheric burst, or by the earth's magnetic field in a high-altitude burst. Consequently a net current flows in one direction or another, and a transient magnetic field is produced.

It is to be expected that nuclear weapons would normally be exploded near the ground for maximum destructive effect, but it is nevertheless conceivable that a combatant might deliberately employ a high-altitude burst solely to create long-range EMP and knock out the enemy's communications and weapons-guidance electronics. EMP is no respecter of political affiliations, however, and such action would be feasible only if its initiator could be certain that his own equipment was adequately protected.

QUANTITATIVE CONSIDERATIONS

It is not easy to calculate the magnitude of the electromagnetic pulse to be expected in any particular situation, because of the number of variables involved. On the other hand little experimental data was obtained up to the time of the voluntary ban on atmospheric nuclear testing, no doubt because valve circuitry was still widespread and the significance of EMP was underestimated. Consequently there is not much information available and what there is is highly classified. Perhaps those nations who have defied the test-ban know more about it, but they are not telling.

Nevertheless sufficient information has been released to indicate that electrical failure will occur far beyond the range of mechanical, heat, or radiation damage. At such distances the peak voltage may rise as high as 10^4 volts per metre and the pulse energy may be several tenths of a Joule. It is probably not enough to damage a 6AK5 or 6BA6 in the front-end of a receiver, but sufficient to weld the contacts of an aerial-switching relay and certainly to burn-out any semiconductor device, confuse a logic circuit, or wipe a core memory.

The threshold energy needed to destroy most semiconductors is of the order of 10^{-7} to 10^{-5}J, but circuit malfunction or memory erasure requires only 10^{-9}J. As the total electromagnetic energy released by a thermonuclear bomb may be as high as 10^{17} Joules, it can be seen that only a very minute proportion needs to be coupled into an electronic circuit to create havoc.

Vulnerable as an individual "black box" may be in itself, connection to power cables or aerial feeders greatly increases susceptibility to the low-frequency component of the pulse; damage may extend to vehicle electrics, land-line telephones, and power distribution systems. A couple of examples have been made public; a very small high-altitude test blew the 8 kV circuit-breakers on a transatlantic cable; and quite a modest surface burst has damaged power transformers over 160 km away.

PROTECTION AGAINST EMP

The possibilities of protecting military electronic equipment against EMP has been stated from two viewpoints; one says: ". . . if nuclear weapons are employed . . . then the majority of the Armed Forces involved in the conflict might as well pack up and go home"; the other implies that all that is needed is a bit of screening and filtering. Obviously the truth lies between these extremes, but probably nearer to the former than the latter. Protection is possible but it is expensive and may involve a considerable trade-off in other directions. The extent of filtering and screening that is required is such that retrospective modification would be almost impossible and certainly completely uneconomic. EMP must be given due consideration from the earliest design stages.

Apart from its magnitude, the most difficult characteristic of the pulse to cope with is its fast rise-time of, say, 20 nanoseconds and wide band-width, with most of the energy concentrated in the LF and VLF region. Spark gaps and gas-discharge tubes, as used for lightning protection and in radar T/R boxes, respond too slowly to protect against EMP, although zener diodes may have some application. Screening by copper or aluminium is relatively ineffective against the low-frequency magnetic field, which demands materials of high permeability.

Similarly, the use of RF filters in power supply leads and other external connections is complicated by the low median frequency of the pulse (around 10-15 kHz). Low-pass filters included for TVI and other EMC attenuation are ineffective at the frequencies carrying most of the EMP energy. EMP protection requires good layout design to obviate inductive loops, steel rather than aluminium for cabinets and instrument cases, specifically designed wide-band rejection filters at external connections, good grounding technique, and resonant antenna systems to minimise out-of-band pickup.

To assess the effectiveness of EMP protection, short of resuming atmospheric nuclear testing, it is necessary to use large and expensive simulators. Overseas versions involve such constructions as a cage-dipole antenna 300 metres long and 20 metres high; or a toroidal radiator 45 metres high suspended from a helium-filled balloon. Only laboratory simulators are available in Australia.

Perhaps the simplest answer to the problem for the WICEN operator is to keep that old valve rig in working order, just in case! ●

MODEL SB404

MODEL SB500

MODEL SA304

MODEL SB300

MODEL SA500

MODEL SA504

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HUSTLER ANTENNAS

Selecting the right antenna is essential for efficient operation of any communications set-up. And it's worth remembering that often the antenna represents only a very small proportion of the cost of a link, yet it has the greatest effect on the overall performance.

The Hustler range is made by Nine Towers in the USA and their antennas have proved popular all over the world. Whether you want fixed or mobile, in any of the bands, there's a Hustler that will offer superior electrical and mechanical performance at very reasonable prices.

All antennas are 50 ohm and require no matching. They all handle the legal maximum powers.

HIGH FREQUENCY ANTENNAS

Fixed station, 4 band trap vertical Model 4BTV covers 10, 15, 20 and 40 Metres with one spring for total band coverage. An optional 80M resonator is also available. No matching, no matching gimmicks, uses only a single feeder. Low SWR over very wide bandwidth (only 1.5:1 at band edges). Heavy duty, low loss mounting brackets. Solid fibreglass traps. Total length 21' 5" and weighs 15 lb. Mounts on a vertical support up to 1½" OD. **$75.00.**

RM80 80M Resonator rated at 400W PEP adjustable between 3750 and 4000 kHz. 42½" long and weighs 1.05 lb. Simply installs on stud of top element of 4BTV. **$23.90.**

Mobile masts for 6, 10, 15, 20, 40 and 80M

Basic Mast MO- is the folding mast that features quick interchange of band resonators. Folds down to only 5' above hook for entering garage etc. Simple, shakeproof sleeve clutch keeps antenna vertical while in use. 54" long operates as ¼ wave on 6M. Made in ½" OD hard drawn brass and heat treated alloy. Stainless steel base to fit mobile mounts (see later). Weighs 1.8 lb. Low SWR and broad band width. **$22.90.**

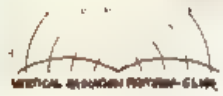
Easy Garaging

Resonators to extend coverage of MO-1. All precision wound and weather sealed. Adjustable stainless steel tip rod and convenient hand edge marker plus positive lock nut and clutch. See accessories for special resonator spring.

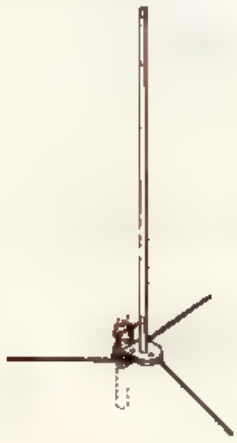
Model	Band	Weight	Price
RM-6	10M	0.42 lb.	$15.90
RM-10	20M	0.45 lb.	$18.90
RM-15	40M	0.80 lb.	$22.50
RM-80	80M	1.05 lb.	$23.90

Fixed Station 2M Colinear QR-144 has an extremely low angle of radiation by combining ¼ and ½ wave radiators. Conservatively rated at 6 db over ¼ wave ground plane, but experience indicates up to 9 db at distances of 20 miles or more. Omnidirectional. Field adjustable Low SWR typically 1:1 at resonance and only 2:1 at 5 MHz bandwidth. 250W FM rating maximum. Radiators, adjusters with 2 matches. SO239 coax connector mounts on American standard stud thread. Ideal Repeater antenna. Weighs 4.5 lb. $64.00

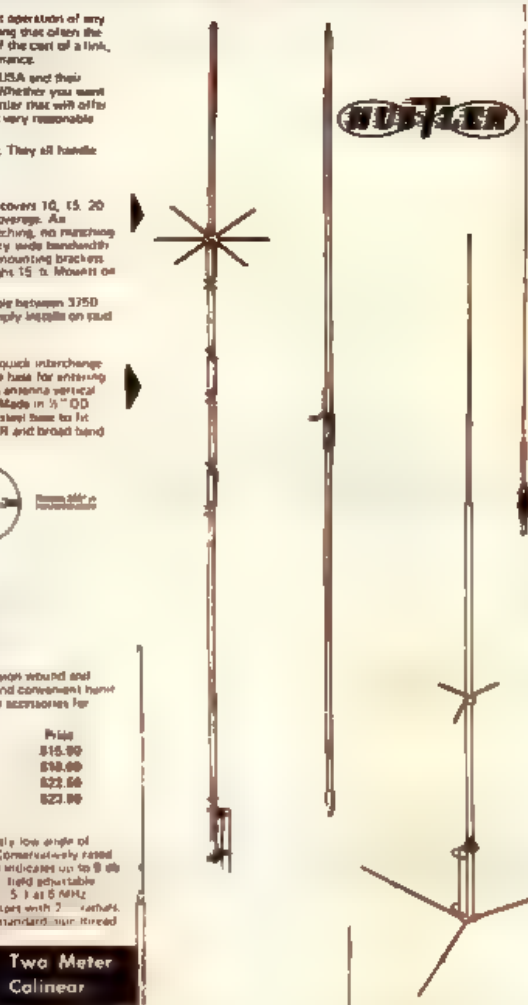
6 db GAIN Two Meter Colinear



VERTICAL RADIATION PATTERN-6 LOBE



Fixed station 2M, 5/8th wave GF-1RK has 3.4 db gain over ¼ wave ground plane. SWR better than 1.15:1 at resonance and 2:1 at 5 MHz bandwidth. Rated 200W. Radiators 47" radials 21". SO239 connector. Unique matching system gives complete feedline decoupling. Supplied with double duty mounting brackets. Weighs 3.5 lb.



SuperGain Mobile CG-144 is a 2M colinear with 5.2 db gain and 200W FM handling. SWR is 1.1:1 at resonance and 1.5:1 at 5 MHz band width. Low angle radiation as with the QR-44. Tempered stainless steel elements. Fits standard mobile mount. 75" long and weighs 1.84 lb. **$37.50.**

Buck Buster BF2 is a 2M, 5/8th wave low cost, quick to install antenna that gives 3.6 db gain over a ¼ wave ground plane. Field adjustable for low SWR (like 1.5:1 at resonance and 2:1 at 6 MHz bandwidth or better). Stainless steel radiator 51" long. Weighs 2 lb. 100W FM handling. Fits standard mobile mounts. **$17.95.**

420-450 MHz two half wave colinear BBL420 for roof mounting or any flat surface. Requires only a ½" mounting hole. 5.2 db gain. Stainless steel radiator 37" long. Weighs 2 lb. SWR better than 1.5:1 full 200W rating, complete with 17' of RG58U cable. **$37.50.**

27 MHz ANTENNAS

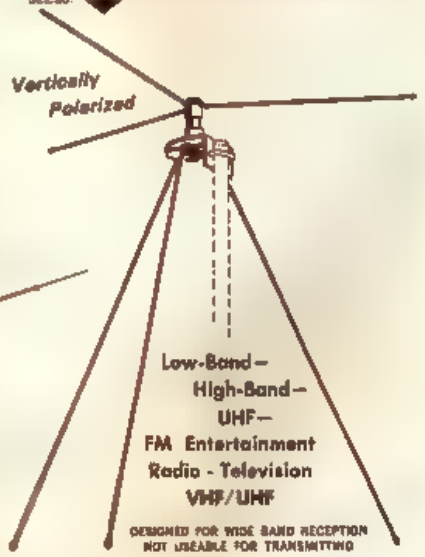
Base station Jem Ram power gain colinear 27JR is made in high tensile aircraft alloy and factory preset so requires no adjustments. Built-in lightning and static precipitators (yes Hustler thought of everything when they designed this one). 4 db gain is highest available and effectively doubles radiated power. SWR better than 1.2:1 over full band width. Up the goes in only 15 minutes to a whopping great 20 feet with 9 foot radials. Weighs 7.8 lb. **$45.00.**

Heavy Duty Base station ground plane GP1 has telescopic alloy elements and angled radials. Omnidirectional. Can be used from 25.64 MHz (free element length chart included). Stainless steel ring clamps. 108" long and weighs 3.3 lb. **$24.50.**

Stainless steel mobile whip SW102 is manufactured in finest 17 7PH taper ground, polished and tempered stainless steel for maximum resistance to weather etc. No tearing or splitting as with cheaper antennas. Full commercial power rating. 102" long and weighs 1.08 lb. Complete with antenna corona ball and operates as full ¼ wave on 27 MHz and can also be used on 50 MHz band. **$11.50.**

Power Master RM11 resonator assembly is a precision wound, weather sealed resonator with adjustable tip for lowest SWR and fits the MO-1 takeoff and standard fittings. Weighs 0.5 lb. **$15.00.**

40-700 MHz Discone DCX is a single large aperture antenna that gives total coverage with excellent match. Very popular with professionals for monitoring all vertically polarised signals. Low band, high band, VHF, UHF, TV, FM etc. etc. right up to 700 MHz. Easy to assemble but use our low loss cable for best performance. Mounts on 1½" OD pipe or flat surface. Cone elements 55" long, disc 20". Weighs 2.5 lb. **$22.50.**



ACCESSORIES

Spaceway Ball Mount C32 is heavily chromed and 180° adjustable. Exclusive rust-slip arrangement in huge 2" diameter ball. Cycolac base for better insulation and lower losses. Complete with Allen key. **$6.95.**

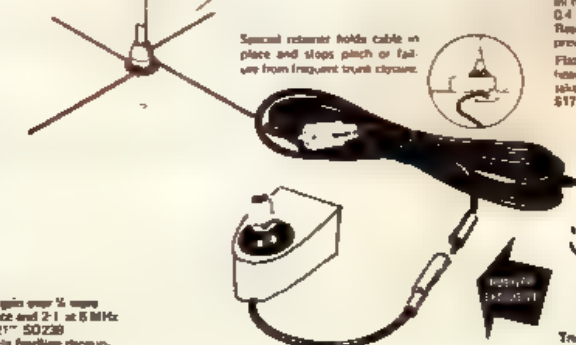
Heavy duty spring coaxial C30 handles whips up to 110" long and has standard couplings. Weighs 1.2 lb. **$8.95.**

Quick Disconnect QD1 in 100% stainless steel. Just push and twist to release everytime. Enclosed mechanism prevents dirt jamming. Suits all mobile antennas having standard male/female mounting. Weighs 0.4 lb. **$16.50.**

Resonator spring RS52 fits between resonator and Hustler antenna to prevent damage from low flying aircraft etc. Weighs 0.36 lb. **$7.95.**

Flat Surface Ball Mount SSM2 is a commercial quality unit with 2" heavy duty ball giving full 180° adjustment. Easy cycolac case will take up slight (3) unevenness on flat surfaces. Complete with all hardware. **$17.95.**

Special retainer holds cable in place and stops pinch or fail-ure from frequent trunk closure.



Track-lip mount TLM needs no drilling and has exclusive cable break connectors for easiest possible installation. Special cable retainer prevents pinching. Suits side or rear mounting of all standard antennas. Complete with 17' of cable and PL259 plug. **$17.50.**

ctronics Centre

TRANSCEIVER H.F.

Kenwood TS-520 160W, SSB transceiver covers 80 to 10 metres. Features noise blanker, VOX, DX switch, 8 pole crystal filter, CW filter etc. Has fully transistorised receiver power supplies. This is a really deluxe job in diecast case, not the usual pressed metal construction. Deliveries due in September, but order now as demand will be heavy at **$550.00** (Road freight extra).

Yaesu Musen FT 101B the famous 160-10 metre, AC/DC transceiver is now available direct from us. Indent price is just **$525.00** (Road freight extra).

Yaesu Musen FT200/FP100 combination also at only **$370.00** (Road freight extra).

H.F. RECEIVER

Trio 9R59DS 0.5 to 30 MHz receiver is still the ever popular budget priced job featuring product detector for SSB. 240V operated. Only requires speaker. New price is down to **$153** (includes freight).

POWER SUPPLY

suitable for use with 27 MHz transceivers and IC22. Fully regulated 12V @ 3A from 240V main **$32.00**

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Hi Gain SSB/AM, 23 channels gives 5W on AM and 15W on SSB. All channel crystals included. Features ANL and noise blanker. PTT mike. Operates on 12V dc and has rf output and S meter. Indent price is only **$260.00** (normal retail is $275).

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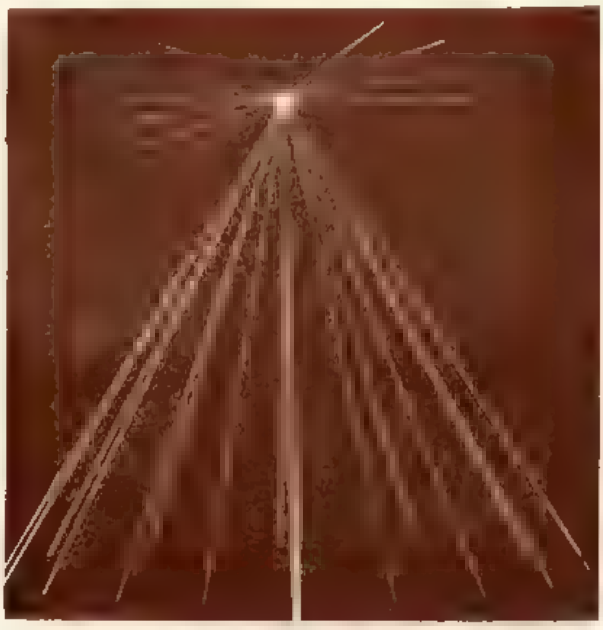

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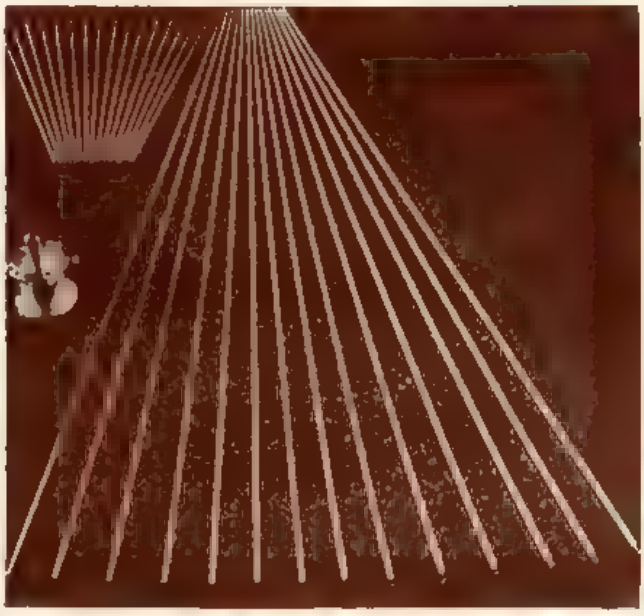

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Audio frequency interference (AFI)

P. W. WATERS, G3OJV
8 Gay Bowers Hockley Essex, U.K
(Reprinted from Radio Communication, April 1973)

THE PROBLEM

The current boom in hi-fi sales has led to an increase in the number of cases of interference caused by radio transmitters operating in close proximity to audio equipment. Almost all audio equipment now being produced for the domestic market is entirely solid state and this changeover from valves to transistors has coincided with a hi-fi boom, making it difficult to assess to what extent transistors are responsible for the increase in the number of cases of interference. Certainly transistorised equipment appears to be far more susceptible than the older valve equipment. Also of significance is the now widespread usage of magnetic cartridges which require amplifier sensitivities of the order of 3 or 4 mV. This usually necessitates one or two additional stages of amplification, whereas the older type of crystal and ceramic cartridges having far higher outputs require far less gain from the amplifier.

Unlike television interference, there is usually very little that can be done at the transmitter end to prevent the trouble. Apart from reducing power, moving aerials or switching off altogether, the cure must be at the complainant's end. Like all kinds of interference this poses a social problem. The average cost of a stereo radiogram is around £80-£100, and for a hi-fi installation comprising separate amplifier, speakers, turntable and possibly VHF tuner the price rises to the region of £150 to £200. Any person having spent this amount of money is not going to take kindly to hearing a burst of CW or "distorted" SSB coming through in the middle of his or her favourite record. Unfortunately, telling your neighbour that the interference is not the fault of the transmitter, but his own equipment, is not going to ease the matter even though it is probably true.

Of course, each case has to be dealt with on its merits and no hard and fast rules can be laid down. It is of prime importance to use tact, patience and common sense. A special mention should be made here of the case of interference from an AM transmitter. A sensitive hi-fi system may well be picking up such a signal and relaying it in "full frequency stereo sound" — a situation which calls for special tact.

THE CAUSE

Before discussing the various ways in which this kind of interference can be prevented, it is necessary to understand how the RF signal reaches the amplifier, is rectified, and emerges at the speaker as an unwanted signal. Fig. 1 shows typical audio amplifier low signal stages. In the case of the transistor version notice the base/emitter junction. This forms a fairly effective junction diode and any RF signal that reaches this stage will be rectified and passed on as an audio signal to the following stages. Similar comments apply to the valve stage. RF energy reaching the grid of the valve is likely to be rectified by non-linear action and the resultant demodulated signal passed on through the following stages as an audio signal. With the modern hi-fi amplifier, having a high overall gain and an output rating of 10 to 15 W/channel or even more, RF breakthrough can be dramatic.

There are a number of paths the radio signal can take to reach the circuitry of an audio amplifier. In high RF fields even direct pickup by the circuit board is possible. Normally, however, the signal is fed to the amplifier via the various connecting cables, which make very good "aerials". Two of the most common sources of trouble seem to be the mains cable and the speaker leads. The mains connection, because of modern ring mains circuits, results in the entire house power wiring being connected to the amplifier and acting as a long-wire "aerial".

As for the speaker leads, stereo reproduction requires a pair of speakers to be separated from the amplifier and turntable unit in order to obtain the stereo effect. In practice this means that the speakers are very often positioned several yards away from the amplifier, the length of twin flex usually used for this purpose making a good "aerial", possibly resonant on or near one of the HF amateur bands. This, of course, ignores the other connecting cables from record turntable, tape unit, VHF tuner etc. It is not surprising, therefore, that a substantial RF signal can find its way into an amplifier several hundred feet distant from the transmitter.

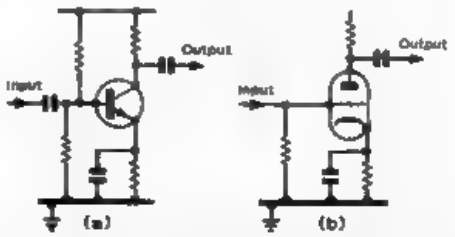


Fig 1. Typical first stages in audio amplifiers which are open to rf interference, (a) transistor, and (b) valve

THE TREATMENT

There are two basic ways of tackling interference in audio equipment. Either the circuit can be modified to prevent the rectification occurring, or the RF signals can be prevented from reaching the amplifier circuitry by fitting filters to the various connecting leads.

Dealing firstly with the rectification problem, it has already been shown how, in a transistor amplifier, trouble usually arises when RF reaches the base/emitter junction of a transistor. Similarly, in a valve amplifier, too much RF energy on the grid can also result in rectification. Clearly, if the RF signal can be bypassed to earth without degrading the wanted audio signal then the problem will be solved. The most obvious solution that comes to mind is to fit a capacitor between input and earth of the amplifier of such a value that while it looks like a near short circuit at RF it offers a high impedance to audio frequencies. Unfortunately, between the input and the transistor base or valve grid may be several inches of wire or circuit board, switch contacts with their associated connecting leads and other components. Bypassing at the remote input socket of the amplifier may therefore not be sufficient. A far more effective method of preventing rectification is to solder a capacitor directly across the base/emitter junction or between control grid and cathode to prevent an RF potential difference between the electrodes.

Fig 2. (a) A suitably chosen capacitor connected between the base and emitter of an early transistor stage will bypass the offending rf to earth without affecting the audio signal. Suitable values are discussed in the text. (b) The analogous modification to a valve stage

Fig. 2 illustrates the required circuit modification. The capacitance value, C, can be around 1,000 pF, although it is by no means critical. The British Radio Corporation recently recommended values of 2,000 pF for one of their transistorised radiograms. This effected a complete cure without affecting the fidelity of the amplifier. Because of the generally higher impedance of valve amplifiers it would be desirable to keep the capacitance value as low as possible and to include an RF choke or 10k ohm resistor in series with the grid to prevent too much loss of high frequencies.

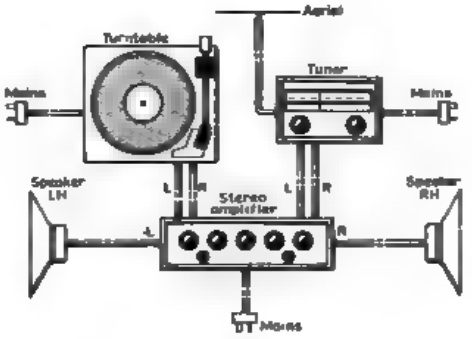
In some cases it will be found necessary to fit bypass capacitors to more than one stage. An indication as to exactly where in the amplifier the rectification is taking place can be obtained by noting whether the level of the interference changes when the amplifier volume control is rotated. Similarly a test should be made to ascertain whether or not rotating the tone controls has any effect on the response of the interfering signal. If the signal is affected by adjustment of any one or all of the controls then the rectification is probably

taking place in an earlier stage. The word "probably" is used deliberately. In a recent case investigated, the RF signal was getting past the first stage and being fed to the following stage via the volume control which was acting as a variable attenuator. Although the control affected the level of interference, the rectification was taking place after the volume control. In practice the fitting of bypass capacitors as shown in Fig. 2 usually results in a complete cure.

Once again there are exceptions to every rule. For reasons which are not clear to the author, there has been a case where the fitting of a capacitor across the base/emitter junction has considerably **increased** the amount of breakthrough. So as an alternative, one or two ferrite beads can be slipped over the base lead of the transistor. However, this can present practical problems if the transistor happens to be soldered very close to the circuit board. In such cases, therefore, an attempt must be made to keep the RF signal out of the amplifier circuitry.

Up until now various ways of preventing RF rectification by modifying the circuitry have been considered, without making any attempt to keep the RF energy out of the amplifier. Very few domestic amplifiers are housed in a sealed metal box, but in a majority of cases the RF signal is introduced into the amplifier by means of the external connecting cables, so this need not be a drawback. For reasons mentioned later it may not be desirable to attempt to effect a cure by working on the internal circuitry. If, as an alternative, a filter can be fitted that will either block the path or short circuit the RF signal to earth, then the interference should cease.

The first step is to find out which lead or leads are acting as aerials. Very often this is likely to be a matter of trial and error, but there are two ways in which identification of the offending lead can be revealed. Firstly, with the AF gain advanced, the various signal-carrying leads into the amplifier should be disconnected. If the interference stops or reduces, then the lead concerned is to some extent acting as an aerial and will require attention as detailed later. Obviously the speaker leads and mains lead cannot be disconnected. The second method adopted by the author, very often revealing which of the leads is causing the trouble, is to couple a grid dip oscillator tightly up against each lead and sweep the tuning dial back and forth. The AF gain control on the amplifier should be advanced so that the background noise of the amplifier can be heard from the speakers. If the lead being tested is conveying RF into the amplifier then an increase in background noise in the form of hum or hiss will very often result when the oscillator is brought into close proximity to the lead. For best results the grid dip oscillator should be modulated by a tone. As amplifiers are very often sensitive to certain bands of frequencies only, it is essential that tests be carried out with the grid dip oscillator tuned across the same frequency range as that from which the interference is being experienced.



Before dealing with the individual leads going to and from the amplifier, a few words regarding the earthing of amplifiers may be in order. Often an amplifier will have a separate earth terminal at the back of the casing. It is sometimes recommended that earthing the amplifier to an earth separate from the mains earth by means of this terminal will help reduce RF breakthrough. Unfortunately the hi-fi installation is very often so situated that a fairly long earth lead is necessary to reach the amplifier. Instead of acting as an earth for RF signals it acts as an extra aerial and will sometimes actually increase the amount of breakthrough by increasing RF energy on the chassis. By all means try the effect of earthing the amplifier but similarly also try **disconnecting** the earth lead if one is already fitted.

The number of separate cables going to an amplifier in a hi-fi installation can be considerable, the actual number varying with the amount of ancillary equipment in use. Fig. 3 illustrates a typical layout.

It has already been mentioned that each cable can be regarded as being an aerial capable of picking up RF signals and feeding them into the amplifier. Clearly a device is needed that will present a high impedance to RF signals while appearing as a low impedance to audio signals. Inductors and capacitors either separately or together in the form of LC networks readily fulfill just this function. The problem with inductors or capacitors is that the former can be bulky items and both often necessitate cables having to be cut and connectors modified during installation.

In recent years ferrite has become a very popular material for use in combating TVI. In particular, it has been found most useful in preventing RF on the outer braiding of coaxial cable finding its way into the TV receiver. In addition to their efficiency, ferrite cores have the major advantage that the existing cable can be used to form the winding, preventing the need to break the cable. One of the most popular ferrite devices is the ferrite ring, on which a very compact winding can be wound. Because of its shape, the cable is self-securing and the complete filter takes only minutes to construct. As a rule of thumb, as many turns as possible should be wound on to the core, with a minimum of 8 or 10 turns.

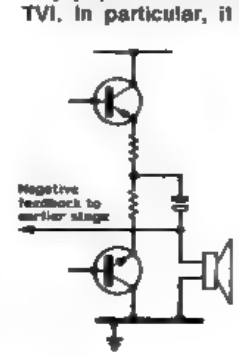
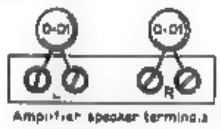


Fig 4. The normal output configuration of a transistor amplifier incorporates a feedback loop to the earlier stages. Thus any rf picked up by the speaker leads can be fed back to the input stages, where rectification and amplification may take place

For combating RF pickup by connecting cables in hi-fi systems the ferrite ring filter is a very effective device. It can be used on speaker cables, leads from the ancillary equipment and main leads. Usually speaker leads and signal leads from record playing units are small diameter cables, and it is quite possible for a common ring to be used for each pair of leads in the case of stereo installations. The actual grade of material does not seem critical and either rod or ring cores can be used. In the author's case great use has been made of Mullard FX1588 rings. It is most important that the filter be installed at the amplifier end of the cable run and as near to the amplifier as possible.

Ferrite inductors are not the only devices for blocking out RF signals although they are probably the neatest and most compact, if not the cheapest. Coaxial cable substituted for the usual twin flex speaker leads will often help considerably where RF is being picked up on the "positive" speaker lead and conveyed back to the early stages of the amplifier via the negative feedback line. See Fig. 4.

Fig 5. To combat mild cases of rf pickup by the speaker leads, 0·01μF disc ceramic capacitors, connected across the amplifier output terminals, can be tried



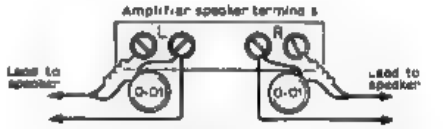


Fig 6. In cases of excessive rf pickup by the speaker leads a combination of capacitor and inductor can be tried

The use of coaxial cable will also prevent the possibility of RF energy being rectified in the transistor power output stage. This can occur even with the amplifier switched off. The author has had one such case and there have been similar cases of interference to transistorised TV receivers reported. Even the nocturnal operator is not clear of this problem! In cases where the RF pickup on the speaker leads is not too severe the use of 0.01 uF disc ceramic capacitors connected across the output terminals of the amplifier can be tried (see Fig. 5). More effective suppression will be obtained if an inductor is also added as shown in Fig. 6.

However, the use of capacitors or coaxial cable cannot prevent RF currents from reaching the amplifier chassis by means of the "negative" speaker lead. In such cases some form of inductance is needed to choke the RF, and the use of a ferrite ring will be found effectively to filter both conductors if twin flex is used for speaker leads.

RF energy picked up on the mains lead can be a problem whether dealing with TVI, BCI or AFI. The solution is the same for all three types of domestic equipment, and a number of different mains filter circuits have been published. Two circuits are shown in Fig. 7. It is most important that capacitors have an adequate AC rating. The inductors can comprise 18 SWG enamel wire on ½ in. former (wood dowel) 2 in. long. Ferrite rod material (such as an old medium wave ferrite aerial with the winding removed) can also be used and will probably be found more satisfactory for the more severe cases. Where a mains filter is used as suggested above, ideally it should be installed inside the amplifier casing, but with the modern tendency to squeeze as much circuitry into as small a space as possible there is very often no room for the inductors required. If this is so, then the filter will have to be installed externally to the amplifier casing and it is most important to make sure that the unit is completely and safely enclosed so that there is no risk of shock. The advantage of the ferrite ring filter mentioned earlier becomes obvious!

Fig 7. Two circuits for suppression of rf pickup on mains leads. It is important that the capacitors have an adequate ac rating, and if the components are mounted externally from the cabinet they should be well-insulated to avoid any risk of electric shock

Earlier, the popularity of the magnetic cartridge was mentioned. This in itself has brought about a new problem, although it is only likely to manifest itself in very high RF fields. Because a magnetic cartridge contains a small inductance, it is possible for RF signals to be induced in the coil and conveyed down the inner conductor of the screened cable to the amplifier. Unplugging the cartridge head from the arm will confirm whether or not this is the cause of the trouble. Ceramic or crystal cartridges will not suffer in this way. The solution is a small LC network installed either at the cartridge head or at the amplifier input, see Fig. 8. Care should be taken to select as low a value of capacitor as practicable to avoid reducing the high frequency response. If the network is installed in the cartridge head, adjustment must be made to the arm counterbalance weight to maintain the correct tracking pressure (often less than 2 gm).

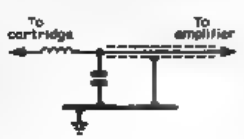


Fig 8. Cases of rf pickup via the coil of a magnetic cartridge can be solved by a simple LC network, installed either at the cartridge head or the input to the amplifier. The lowest possible value of capacitance should be chosen, to avoid any reduction in the hf response of the system

VHF tuners are susceptible to two different forms of interference. The RF energy can either get into the front end of the tuner causing interference to radio programmes only, or alternatively it can be picked up on the VHF coaxial down lead and conveyed back to the amplifier via the chassis of the tuner to cause audio breakthrough. RF energy picked up on the outer coaxial braiding can be prevented from reaching the amplifier either by inserting a ferrite ring filter or using a 1 : 1 transformer, see Fig. 9. Both are familiar devices for TVI sufferers. If, however, the interference is found to be tunable on the VHF tuner, or only present when it is switched on, then there is a strong possibility that the RF signal is being picked up on the FM aerial and a simple high-pass filter as used for TVI should clear the trouble. The need for the receiver to be provided with an aerial adequate for the area applies just as much to FM reception as it does to TV reception. Normally this means an FM band dipole in the loft or on the roof but in some areas, particularly where stereo reception is required, a three- or four-element beam is needed.

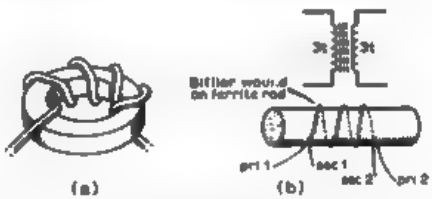


Fig 9. RF pickup on the coaxial braiding of the lead from vhf tuner to amplifier can be cured by either a ferrite ring filter or a 1 :1 transformer

When dealing with cases of hi-fi interference it is essential to realise the importance of keeping all leads as short as possible and this applies in particular to speaker leads. A problem which has given the author some trouble in the past is the re-radiation of signals from one cable to another (TVI sufferers please note). If a lead has had to be filtered then keep it as far away as possible from other leads. Try moving the various connecting leads to the amplifier about in relation to one another and if a number of leads have been taped together try unwrapping the tape and separating them. Very often a speaker lead will be tacked along the skirting board with the mains cable and RF will be induced from one to the other. In the author's case laying the TV aerial coaxial lead next to the speaker leads results in severe audio breakthrough while separating them a few inches completely clears the trouble. Never allow any excess cable to trail over the floor. It should either be shortened or coiled up and taped. The importance of this point cannot be over-emphasised.

THE SOCIAL PROBLEM

There is virtually nothing that the amateur radio operator can do at the station end to prevent causing audio breakthrough, apart from reducing power, unless he is prepared to change his mode of transmission. The latter option has been taken up by a number of VHF operators by switching from AM to FM. The A1 CW operator has the option to change to F1 but this is hardly likely to find much favour on the HF bands and is likely to confuse some operators who may tune to the space instead of the mark. The great difficulty in handling cases of interference is explaining to the sufferer that the fault is with his equipment and not the amateur's. No hard and fast rules can be given as each case is different and personalities and attitudes vary widely. Basically a combination of diplomacy and firmness is required.

The question of whether or not the job of curing the interference is to be undertaken by the amateur concerned is a matter of personal discretion. The author does not favour the idea of carrying out work involving the opening up of amplifiers. This is fine if the amplifier is one's own, but be very careful before deciding to carry out any work on a neighbour's equipment. Really it is a job to be carried out by a paid service engineer, not necessarily because the amateur involved is not capable of doing the work but because anything that goes wrong subsequently is likely to be blamed upon the amateur. If a neighbour does ask an amateur if he would be prepared to carry out the work he should think very carefully before deciding, and if in doubt — refuse.

The question then arises as to who carries out the work. The listener is not likely to have the knowledge to carry out the work himself. He may also be unwilling to pay to have the work done for him if he considers the amateur at fault. Even if he does decide to employ the services of a paid engineer or dealer the time taken up in tracing the trouble is likely to be considerable and many dealers will just have no idea where to start. A major portion of responsibility must be with the manufacturer who designed and made the equipment. In this respect the British Radio Corporation has been found to be particularly helpful. Unfortunately, many manufacturers seem surprisingly disinterested in the short-comings of their equipment although some do provide a certain amount of help and advice in the way of technical correspondence, circuits and perhaps a few components. We therefore find ourselves caught in a vicious circle with an embarrassed amateur and an unfortunate and possibly irate sufferer.

It is hoped that this article will encourage rather than deter amateurs trying to solve their audio breakthrough problems. During the 'fifties and 'sixties TVI has been a big problem, but through the persistent work of the RSGB local groups and individuals the problem has been overcome by many. Audio breakthrough looks like being an even bigger problem to be faced in the 'seventies. The solution is mainly with the manufacturers but it is up to the amateur movement as a whole to make them aware of the problem with a view to persuading them to raise their standards. ●

INTERFERENCE BIBLIOGRAPHY

Compilation and comments by Peter Dodd, VK3CIF, and Rodney Champness, VK3UG

Good state of the art design and construction practices allied to correct operating of the transmitter or receiver are sometimes not sufficient to prevent interference from raising its ugly head. The following references could be found useful in following up various ideas to rid yourself of the problem. The list is by no means complete, but even so does cover more than seventy references. Where necessary explanatory notes are included with the article title.

BOOKS

In the amateur field a must book is the **Television Interference Manual** by the **RSGB** and reviewed on page 20 of AR May 1973. This must, of course, be read in conjunction with the **PMG's Handbook**, which is at present under examination for revision.

The **ARRL's Radio Amateur Handbook** contains much sage advice on interference. In the 1974 edition this will be found in Chapter 16 beginning on page 484. In the same edition front end receiver overload problems are dealt with in the receiving system chapter (p. 262).

The **RSGB's Radio Communication Handbook** also contains a chapter on **INTERFERENCE** — Chapter 16 beginning on page 16.1 with another bit in Chapter 4 — p. 4.25. Other useful tips can be found in the **RSGB's Amateur Radio Techniques** by Pat Hawker.

Articles from AMATEUR RADIO

Report of the First TVI Field Test. July 56. (Interesting information gained during the early days of TV in Australia).

Anti TVI Filters for the Amateur Transmitter. Nov. 56. (Good design data by Hans Ruckert.)

Low-Pass Filter Home building Simplified. Oct. 56. (Follow up article to the Nov. 56 article.)

Understanding Television Interference. Oct. 66. (A QST reprint.)

Diagnosis of TVI — A system of locating the cause of interference. Jan. 67.

Prevention of Interference by Television Receivers. May 56. (How do we convince manufacturers that this would be a good idea?)

TVI Diagnosis Chart. May 60. (Similar in some points to Jan. 67 article.)

Sideband — Visual Monitor. Sept. 60. (A 913 CRO tube in a simple monitor.)

AM Without Splatter. Feb. 61. (How to run high modulation level without causing interference.)

Recent Trends in Receiver Front End Design. Noise Figure and Cross Modulation Characteristics of Tube and Transistor Front Ends. Jan. 64. (Have you ever wondered why you hear stations that shouldn't be there?)

Considerations in Receiver Front-End Design. March 64. (How to improve the performance of receivers to reject unwanted signals.)

Corrosion. March 65. (The effect of dissimilar metals on one another in a salty atmosphere. The same types of things can cause external cross-modulation of your signals and perhaps cause TVI. A corroded TV aerial or rusty fence for example.)

Lightning. April 66. (QRN? — QRN5.)

Federal Comment. May 71.

Australian Standards for Electro-Magnetic Interference. May 71. (A few draft interference specifications and E.M.C.)

1974 Easter Federal Convention. June 74. (Section 11 Interference. A policy statement well worth reading.)

An Effective Noise Silencer — using a separate noise receiver. April 63. (Good background information. May be obsolete in light of more recent developments.)

Ignition Noise versus Frequency. May 64. (A graphical indication of frequencies worst affected by ignition interference.)

Keeping out of that Modulated Milk Bottle. July 64. (Suggestions on methods of transmitter construction and operation to minimise TVI.)

Some Aspects of Spurious Radiations from Amateur Transmitters (R. Gurr). Dec. 64. (Methods to keep your amateur transmitter clean of HF spurious.)

Some Low Pass Filter designs for Amateurs. April 66. (Three low pass filters for attachment to the output of HF and VHF transmitters.)

Noise Limiter for Mobile use. June 66. (A simple single diode limiter.)

Some Thoughts on Six Metre TVI. August 66. Roy Hartkopf. (Good sound philosophy on public relations as well as suppression methods.)

Interference to Television and Radio Reception by nearby Radio Communications Transmitters. Nov. 66. Gurr and Murphy. (Traps and filters to be fitted to TV and Radio receivers.)

TVI — It can be eliminated . . . well, nearly always. Aug. 69. (A simple cheap filter.)

A Graphical Method for Locating Interfering Beat and Harmonic Frequencies. Feb. 70. (Of use to find out possible spurious outputs from SSB transmitters.)

Two-Stub Notch Filters for TVI. July 71. (Attenuation of unwanted frequencies by up to 80 db. Applicable to transmitters and TV sets that use coaxial cable feed.)

Tackling TVI. April 72. (Methods of suppression and ideas used in England. A reprint.)

Building Modern Filters. Oct., Dec. 72 and Jan. 73. (Designing filters both AF and RF.)

Television Interference Manual RSGB publication, reviewed May 73. (A worthwhile addition to your library.)

A Noise Blanker for the Trio TS510 Transceiver. Jan. 73.

TVI on 6 metres. Jan. 73. (Reasons why you cause TVI, selectivity curves of TV set IFs, etc.)

Constructing a LP filter. Jan. 73 (35 MHz cutoff filter, with 80 db attenuation at 60 MHz.)

Audio Rectification Hints — Interference. Sept. 73. (Keeping out of people's Hi-Fi.)

TVI, BCI and the Irate Neighbour. Newcomers (Notebook. Jan. 74. (Understanding your neighbour, Public Relations.)

Newcomers Notebook. May 74. (Thoughts on shifting the 6 metre net to 53.995 MHz.)

Simple High Pass Filter. March 74. (Similar to the one in Aug. 69 issue.)

Articles from RADIO AND HOBBIES, ELECTRONICS AUSTRALIA

The VHF Bands — what to do about TVI problems. Part 1, 52-54 MHz. May 64.

The VHF Bands — what to do about TVI problems. Part 2, 144-148 MHz. June 64.

Television Interference from Power Lines. March 66. (An extremely interesting article on TVI as caused by power lines. They also cause interference to radios and communications services too.)

Lamb type Noise Silencer using valves. August 66.

A Line Filter for heavier loads. Oct. 66. (1 KW on BC bands and above.)

Noise Silencers — A development model using transistors. Dec. 66. (Lamb type noise silencer.)

Suppressing Impulse Interference. A Reader Built It. Oct. 70. (Thermostat Clicks, contactors, etc.)

Easily Adjusted Low Pass Filter. Nov. 71, page 76. (An extract from **Radio Communications.**)

A Power Line Filter. June 71 (BC band and similar frequencies.)

A Power Line Filter. August 71. (Modifications to the unit described in the June issue. Smaller value suppression capacitors.)

EA240 Communications Receiver. Jan., Feb., and March 70. (An interesting and apparently quite successful Lamb Noise Silencer. Not all Silencers are what they are cracked up to be.)

Toroid filter minimises Radio, TV Breakthrough. June 74.

Articles from ELECTRONICS TODAY INTERNATIONAL

RF Interference. Nov. 71. (A general article.)

Articles from BREAK IN

Ignition Interference in New Zealand. Oct. 70. (A general article by the New Zealand Post Office.)

How to Handle Hi-Fi Interference. Nov. 70. (A helpful reprint from QST.)

Radio and Television Interference from Electrical Appliances. Dec. 73. (An article showing many methods of alleviating interference to receiving equipment caused by electrical appliances.)

Articles from HAM RADIO

Noise Radio-Frequency Interference. Dec. 70. (A general article dealing with a wide spectrum of problems.)

Eliminating Engine Interference. March 74, page 63. (A book review of what appears to be an interesting book that may well be a desirable addition to the mobile amateur's library.)

Arc Suppression Networks. The Ham Notebook. July 73. (For contactors, etc.)

Articles from RADIO COMMUNICATIONS

Cross-Talk. In the beginning, and Start off outside peak viewing hours. July 72. (Public Relations ideas on living with your neighbours.)

Cross-Talk. Friends and Neighbours. June 72. (Public Relations ideas.)

Cross-Talk. RFI — Don't go it alone. May 73. (Public Relations ideas.)

Audio Frequency Interference (AFI). April 73. (An extremely interesting and informative article.)

Practical Braid-Breakers using Stock Materials. Nov. 72. (More applicable to British TVI problems where coaxial cable feeder systems are used.)

Article from TELEVISION

Curing RF Interference. Jan. 74. (Similar to the last two Radio Communications articles but attacking the problem from a slightly different direction.)

Article from POPULAR ELECTRONICS

Electronic Pollution . . . An Impending Crisis. April 73. (A very interesting article on the ever increasing level of total noise. Even country areas are becoming polluted the way.)

Article from THE FIREMAN

RF Noise and Vehicle Mobile Communications. March 72. (This is a small sect on of information presented by Mike Russell-Clarke of the Country Fire Authority at an IREE (Aust.) Radio Interference Workshop.)

Articles from QST

Exit Ignition Noise — Eliminating Automotive Noise by Shielding the Car Ignition System. May 59.

Hi-Fi and Electronic Organ Interference — How to Clean It Up. June 66.

A Noise-Locator Receiver. June 66.

Electrical Interference. Part I — Causes and Identification. April 66.

Electrical Interference. Part II — Tracking and Cure. May 66. (The follow-up article of April 66.)

Recent Equipment — Shielded Ignition Systems. Aug. 64. (A run down on various commercial shielded ignition systems available in the United States.)

TVI is Still With Us. Dec. 68.

Beginner and Novice — How to Handle TVI — Useful information on what to look for. April 67.

Absorptive Filter for TV Harmonics — and a Novel Filter Construction Technique. Nov. 68.

Beginner and Novice — How to Handle Hi-Fi Interference — A cautious approach to a sticky problem. June 70. (This was reproduced in Break In in Nov. 70.)

Power-Line Interference — Its Causes and Methods of Location. July 70.

Beginner and Novice — RFI. July 72. (Designed mostly for those who suffer with AFI.)

Hints and Kinks for the Experimenter. Locating Sources of Man-Made Noise. Feb. 74.

If you count the number of references shown in this article you will see over 70 separate articles listed. It is believed that this list contains more than sufficient information for the average amateur to make a success of clearing up interference within his jurisdiction. Naturally enough many of the listed articles overlap one another, each carrying a slightly different slant on common problems.

The IEEE Transactions on EMC are published quarterly at $6 per copy for non-members, and may be of interest to some as reference material.

There are many other magazines which have had articles on interference. For the suppression of motor vehicles (including suppressing specific models of cars) probably as detailed descriptions as anywhere appear in **Mobile News** the journal of the (British) **Amateur Radio Mobile Society.** Detailed suppression requirements for specialised equipment often appear in publications referring to the apparatus concerned — e.g. for RTTY machines see the **RSGB Teleprinter Handbook** page 2.3. There are two firms who may be able to help with information and components for vehicle suppression namely — **Joseph Lucas (Aust.) Pty. Ltd.,** of Cheltenham, and **Robert Bosch (Aust.) Pty. Ltd.,** of Clayton, both of Melbourne — there may be branches in other States, however.

Newcomers Notebook

with Rodney Champness VK3UG

44 Rathmullen Rd., Boronia, Vic., 3155

AUDIO FREQUENCY INTERFERENCE — HOW IT HAPPENS

You could be excused for not understanding how a piece of audio equipment such as a Hi-Fi amplifier responds to the RF signal from a radio or television transmitter. The reasons for an audio amplifier responding to RF are simple. A manufacturer should have little problem in making his equipment immune to RF signals if proper tests and corrective action are taken at the design stage. The actual cost of making the equipment RFI proof should not increase production costs more than about a dollar per unit. Most manufacturers seem more interested in total sales than in producing an item that a customer will be completely happy with.

In Fig. 1 a typical rudimentary transistor audio amplifier stage is shown. This stage will act as a RF detector if any RF signal which exceeds about 50 mV or so is present on the base lead. Once again you could be excused for saying that this is not possible as the transistor is biased on with a voltage of 0.6 volts between base and emitter. Regrettably 0.6 volts is not the voltage that is necessary to cause this transistor to act as a diode detector instead of a linear audio amplifier. I have deliberately shown this transistor as a high

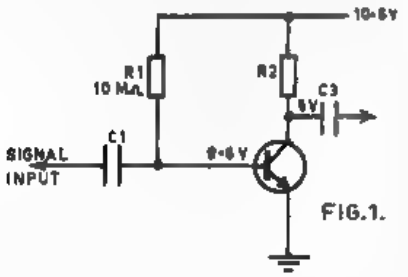


FIG.1.

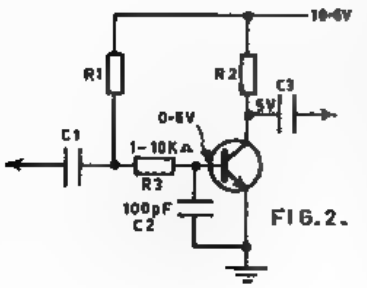
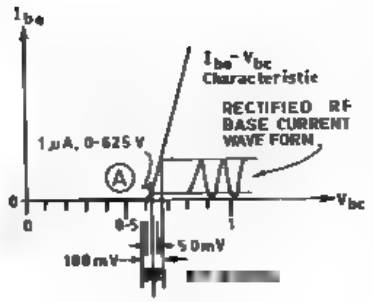


FIG.2.



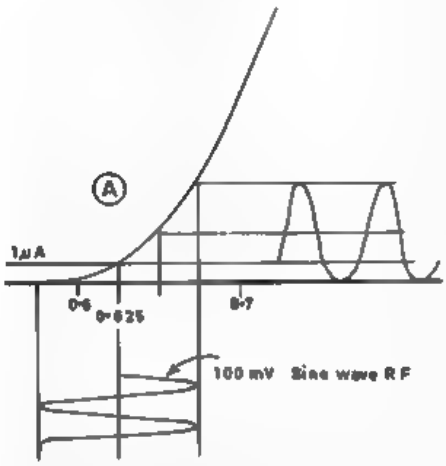


FIG.3. BASE RECTIFICATION. Collector current will vary at modulation rate.

gain type running very little collector current; the base current is very low at 1 uA. The base emitter junction can be considered as a forward biased diode. A diode of the silicon type requires a forward bias in the region of 0.6 volts to cause it to conduct. In this particular circuit in Fig. 1 the diode (emitter-base) is just turned on with 1uA of forward bias current.

This means that very little variation from this 1 uA current, 0.6 volt forward bias will cause the diode to rectify the signal applied to its base whether it is AF or RF. It is in fact a high impedance very low level audio amplifier and, as such, very susceptible to high level signals of any sort. If, for example, this transistor has a switch on voltage of exactly 0.6 volts and with 1 uA base current the voltage is only 25 mV more than this, it means that signals with a peak to peak level exceeding 50 mV or an RMS level of 17.5 mV will cause this transistor to act like a diode detector — a crystal set! The leads to the base of the transistor should it be in the front end of the amplifier will probably be quite long, up to several feet. These leads usually go via switches and long, sometimes unshielded, leads to the pick up head of the record playing turntable. These long leads are ideal for picking up RF signals from nearby transmitters and in some cases not so nearby transmitters. These signals do not need to be very strong to cause trouble, in the order of 17 mV in this hypothetical case. A broadcast station can easily produce an RF field of several mV at a distance of several miles. An amateur station at a 100 feet may well induce an RF field of several hundred millivolts. Several hundred millivolts would certainly cause a sensitive AF stage to act like a crystal set detector.

Fig. 2 shows how an audio stage can be RFI proofed by the addition of 2 additional inexpensive parts These two components short circuit the radio frequency component to earth. They form a basic low pass filter, with a loss factor of 3 db at frequencies varying from 150 kHz to 1500 kHz If R3 is 10k ohms the response of the audio amplifier will be down by 3db at 150 kHz, the response at 1.8 megahertz is down by about 22db, at 14 megahertz the response is down by about 39 db on the audio response. At 14 megahertz the critical level instead of being about 17 mV as in the unsuppressed amplifier is now a figure of something like 1.5 volts. That is some difference. It does help in the first instance if all likely critical leads are shielded so that the actual RF brought into the case of the amplifier is at as low a figure as possible. At times a small ferrite bead worth a cent or two slid over the base lead of the transistor can help considerably to reduce interference pick up particularly at VHF. The ferrite bead acts as an RF choke.

I hope this short article has helped you to understand how AFI suppression is achieved. The suppression of interference is not the impossibly hard job that many people would have you believe. They probably think it is hard because they have not taken the time to really find out how interference is caused, and how it can be cured. There is these days less reason for not being able to fix interference as much more sophisticated equipment is available than previously. ●

Try This

with Ron Cook VK3AFW and Bill Rice VK3ABP

ANTI-TVI TRAPS

You know (we hope) that your 6 or 2 metre transmitter is correctly modulated and harmonic-free. But the neighbours or the XYL complain of TVI on channels 0, 1,5A, and perhaps others. Try this very simple, sharply-selective trap which can be fitted to the TV set. The idea is old but there may be newer amateurs who are unaware of it.

Take a length of 300 ohm TV ribbon (between 12 and 20 inches for 6 metres, 3 to 4 inches for 2 metres) Solder the conductors together at one end, and across the other end connect a stable screw-adjusted (i.e. multi-turn) trimmer capacitor. The mica-compression type is not recommended, but may do for 6 metres. Use 3-30 pF for 6 metres, preferably 1-10 pF for 2 metres. This combination of ribbon stub and trimmer forms a very high-Q tuned circuit.

The trap circuit is now coupled into the

TV feeder ribbon (but not connected to it) simply by placing their flat sides adjacent and taping together with a few pieces of PVC tape. The trimmer end of the trap should be near the TV antenna terminals. A possible refinement is to fasten the trimmer physically to an insulating bracket (or the cabinet back, if non-metallic). With the transmitter operating, carefully adjust the trimmer, **using a plastic adjusting tool.** At one critical setting the TVI should disappear.

These traps are sharp enough to have no effect on TV reception when tuned to the adjacent amateur-band frequency. For this reason they do not permit you to QSY far from the set frequency, perhaps 100 kHz on 6 metres. Also they may need periodic readjustment, particularly if the trimmers used are not highly stable. But they do work! Unfortunately, if too many are needed in your vicinity you may also have to reduce power, go mobile, use another band, or shift QTH!

VHF UHF an expanding world

with Eric Jamieson VK5LP

Forreston, S.A., 5233
Times GMT

VK0	VK0RG, Macquarie Island	52.150
	VK0MA, Mawson	53.100
	VK0GR, Casey	53.200
VK1	VK1RTA, Canberra	144.475
VK2	VK2WI, Sydney	52.450
	VK2WI, Sydney	144.002
VK3	VK3RTG, Vermont	144.700
VK4	VK4WI/2, Townsville	52.600
	VK4WI/1, Mt. Mowbullan	146.400
VK5	VK5VF, Mt. Lofty	53.000
	VK5VF, Mt. Lofty	144.600
VK6	VK6VF, Perth	52.3015
	VK6RTU, Kalgoorlie	52.350
	VK6RTT, Carnarvon	52.900
	VK6RTW, Albany	144.600
	VK6VF, Perth	145.000
VK7	VK7RTX, Devonport	144.900
VK8	VK8VF, Darwin	52.200
P29	P29GA, Lae, Niugini	52.150
ZL1	ZL1VHF, Auckland	145.100
	ZL1VHW, Waikato	145.150
ZL2	ZL2VHF, Wellington	145.200
	ZL2VHP, Palmerston North	145.250
ZL3	ZL3VHF, Christchurch	145.300
ZL4	ZL4VHF, Dunedin	145.400
JA	JA1IGY, Tokyo	52.500

No advice of any alterations, additions etc. to above list. Everyone must be satisfied, no one complains!

SIX METRES

"The six metre band never closes." So said Rod VK2ZQJ some years ago; seems he has been proved right plenty of times. On 2nd July around 0250Z for about 3 hours band open between VK2, 5 and 7, signals around S9. Strong TV signals from Brisbane on 4/7. On 14th July, open between VK2, 3, 4, 5 and 7, with northern VK4's very strong. MUF well up, probably approaching 100 MHz. Conditions continued into next day again with northern VK4s strong. By Monday 16th, signals had dropped off but still VK4s around. Plenty of Channel 0 activity at odd times throughout remainer of July, little else heard. Weak CW on 52.050 from VK2 one occasion, riding in and out of the noise, nothing positive, may have been Wally ex VK5ZWW testing!!

Nothing to report on two metre scene. Rod VK2ZQJ still looking for 2 metre M/S contacts, no takers so far.

DAPTO MOONBOUNCE PROJECT

Lyle VK2ALU sends along his usual information about the workings of VK2AMW. Appears calculations giving a 2 hour time error did not help the proposed tests on 22/6/74, with ZE5JJ in Rhodesia, and G3LTF.

VK2ZHU recently placed the transmitter cubicle heater box in position in an effort to stop corrosion of relay contacts which has been a source of trouble, and construction of a new transmitter frequency source is proceeding.

The Dapto Group has received advice from the PMG Department that their high power permit has been extended until April 1975, and provision made to cover the use of the F1 and F2 modes (RTTY) in addition to A1 and A0 modes.

G6JP

George Jessop, G6JP, is the President of R.S.G.B. for 1974. Licensed in 1929 as 2AYP and granted a radiating permit as G6JP in 1930, George was one of the pioneers of VHF communication in 1933 and was one of a team which demonstrated the feasibility of VHF air to air and air to ground communication, a factor of considerable importance in World War 2. George has written many articles and books on VHF of which the R.S.G.B. VHF/UHF Manual is but one. (From Break-in, June 1974.)

Well, that's it for this month. Overall activity close to nil. Closing with the thought for the month: "With man's great ability to think and reason and compute, we can now pinpoint most of our current problems. The trouble is we can't solve them."

The Voice in the Hills.

Y.R.C.S.

with Bob Guthberlet

Methodist Manse, Kadina, S.A., 5554

The July issue of a Newsheet published by the University of NSW Amateur Radio Society gives the names of 20 candidates who have passed the full and limited Amateur Licences. We offer our congratulations to the successful students, and to the Society which is a member of the WIA — Y.R.C.S.

The Newsheet also includes a letter submitted to the WIA the contents of which should be read by Amateurs, not only in NSW but also throughout Australia.

With a population of over 3 million people here in Sydney and with the Youth Radio Club Scheme (Y.R.C.S.) having been established in 1962, one would think that in 1974 there would be thousands or at least hundreds of people actively studying through clubs or correspondence here in Sydney. This is not the case. Its not the fault of Y.R.S. They have an excellent syllabus and guide for clubs and individuals wanting to study. It's up to us all to start supporting the dedicated few at Y.R.S. in an activity which has been long neglected by the Sydney Amateur. We all listen each week of each year to the effort put into Y.R.S. by the Maitland Radio Club in serving the people of that town and district. Yet what are we doing for the people of Sydney? It's up to the amateurs in this city to do something about the situation. We at NSW University have formed an amateur radio club affiliated with the WIA and hope to organise displays and encourage Y.R.S. courses to be established in local schools, and in our own University. Please give some serious thought as to how you, as an amateur can assist the community. We at NSW University are trying our best but with over 3 million people out there much more needs to be done."

On behalf of WIA—Y.R.C.S. I thank the University of NSW Amateur Radio Society for sharing our aims and concerns.

Commercial Kinks

with Ron Fisher VK3OM

3 Fairview Ave., Glen Waverley, 3150

A HELICAL WHIP FOR THE KEN AERIAL

If you have trouble getting tangled up in the standard telescopic whip on your KEN, perhaps you might like to try this six inch helically wound whip. Designed by Don Paice VK3ADP, the performance is in every way comparable to the standard length whip.

Before commencing construction of the helical it is necessary to modify the KEN to take a BNC antenna socket as in the previous section. The whip is wound on a section of fibreglass rod, ⅛ inch diameter at the base and tapering to 5/32 inch at the top. The length of the rod should be 5½ inches to allow 5 inches for the antenna plus ½ inch to fit into the BNC plug. Winding data for the antenna is as follows. Using 26 gauge enamel copper wire 47 turns are wound close spaced over the top 1½ inches with 18 turns spaced over the bottom 3½ inches.

The actual adjustment to frequency is quite critical, and of course should not be attempted on the KEN. Best connect the antenna through an SWR meter to your old valve transceiver or transistor final that has high SWR protection. The final adjustment will be to less than half a turn at the top of the whip.

When completed, the winding should be coated with an epoxy resin such as "Araldite". The finished job should look like the one illustrated.

FT2FB REPEATER PROBLEMS WITH THE FT2FB

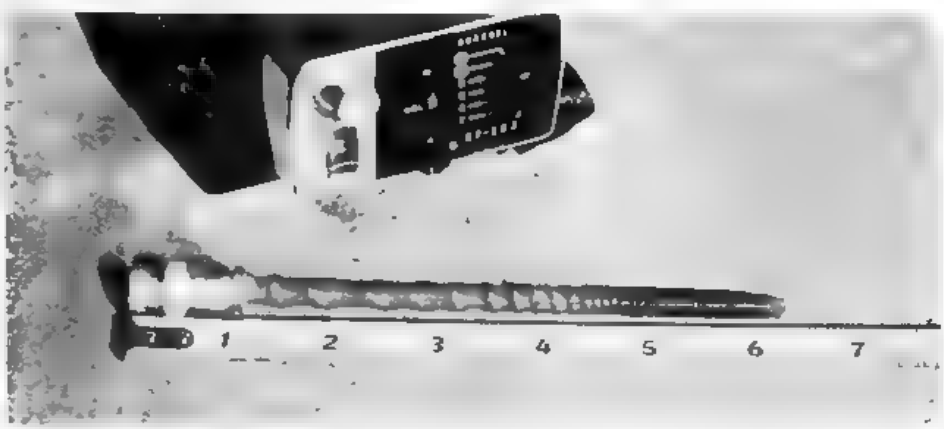
With the change to 147.0 MHz for the receive frequency of repeater channel four quite a few FT2FB owners have run into trouble with a spurious signal on this channel.

It appears that the trouble is caused by a beat between the second harmonic of the first conversion oscillator beating with the third harmonic of the second conversion oscillator. This occurs when the second conversion crystal is on 10.245 kHz and not on 11.155 kHz as indicated on the FT2FB circuit.

Correspondence with Yaesu indicates that they use both frequencies in order to avoid spurious responses on particular frequencies. They do not state however which spurious responses are avoided by using 10.245 kHz.

So, if you are in trouble with the new channel four, check your transceiver and see which frequency the second conversion crystal is on. Do not rely on the circuit as these are all shown as 11.155 kHz. Check the actual crystal.

The cure is to change to 11.155 kHz. It seems that Yaesu might exchange crystals. They have offered to do this in my case, however, I suggest you contact them before sending off your crystal.



Contests

with Jim Payne, VK3AZT

Federal Contest Manager,
Box 67, East Melbourne, Vic., 3002

CONTEST CALENDAR

Sept.	14/15	European Phone Contest
Sept.	14/15	Scandinavian CW Contest
Sept.	21/22	Scandinavian Phone Contest
Oct.	5/6	VK/ZL/Oceania Phone Contest
Oct.	12/13	VK/ZL/Oceania CW Contest
Oct.	12/13	RSGB 21/28 MHz Phone Contest
Oct.	19/20	RSGB 7 MHz CW Contest
Oct.	19/20	SCOUT JAMBOREE
Oct.	26/27	CQ WW DX Phone Contest
Nov.	2/3	RSGB 7 MHz Phone Contest
Nov.	10	Czechoslovakian CW & Phone Contest
Nov.	23/24	CQ WW CW Contest.

WHEN IS YOUR CLUB OR DIVISION HOLDING A CONTEST?

EUROPEAN PHONE CONTEST

0000 GMT 14th Sept. — 2400 GMT 15th Sept.

Only 36 hours operating for single operator station one Rest period of 12 hours may be taken in not more than 3 periods. QSO numbering starts with 001.

Multiplier a number of EU countries worked. In addition the multiplier on 3.5 may be multiplied by 4, on 7 MHz by 3 and 14/21/28 by 2.

Logs to WAEDC Contest Ctee, D-895, Kaufbeuren, Box 262, West Germany.

RSGB 21/28 MHz PHONE

0700 GMT 12th Oct. to 1900 GMT 13th Oct.

VK stations may only claim points for contacts with stations in the British Isles.

Scoring — 5 points each contact plus 50 points for first contact on each band with prefixes G2, 3, 4, 5, 6, 8, GC2, 3, 4, 5, 6, 8, GD2, 3, 4, 5, 6, 8, GI2 3, 4, 5, 6, 8, GM2, 3, 4, 5, 6, 8, GW2, 3, 4, 5, 6, 8. GB prefixes do not score bonus points.

Awards to highest score each VK area. Entries to RSGB HF Contests Ctee, 123 Clensham Lane, Sutton, Surrey SM1 2ND, England to arrive before 9th Dec. 1974.

RSGB 7 MHz DX

CW 1800 GMT 19th Oct. to 1800 GMT 20th Oct.

Phone 1800 GMT 2nd Nov. to 1800 GMT 3rd Nov.

Scoring — VK stations may only work prefixes as listed in RSGB 21/28 phone contest above. 50 points per contact plus bonus 50 points for first contact with prefixes listed above. Awards to highest score each VK area.

Entries to reach HF Contests Committee, c/o J. Bazley G3HCT, Brooklands, Ullenhall, Solihull, England, by 16th & 30th Dec. for CW & Phone respectively.

CONTEST INFORMATION

Details of most contests are received some months in advance of the events and a photocopy of rules etc will be forwarded if a SASE is sent to the F.C.M. at his home QTH in the call book.

ROSS HULL CONTEST

Bob VK3AOT has suggested some alterations to the scoring table which could be considered concurrently with metrification. Some of the "Champs" have been requested to comment and replies to date are most informative but unfortunately suggest more alternatives. One is "That a bonus of 1000 points be claimed by any station breaking an existing record on any band. (Page 19, AR, June 1974). This is just another incentive; after all the purpose of the contest is "to perpetuate the memory of Ross Hull, who did so much to Further the VHF/UHF" The last words should be the key in weighing a scoring system in favour of activity rather than solely on the chances of a contact being made.

Another reply states "I think Bob's modifications will help to give most operators a better chance of winning the contest and should be implemented for the coming contest. The modifications (alternative C) are not the complete solution to the problem but should be regarded as an interim measure for the 74/75 contest as time does not permit thrashing out any drastic changes. I believe that a far better system of scoring would be to remove all distance boundaries as they exist at present! Unforunately space does not permit publication of a very carefully prepared scoring table which was received with that letter.

Another letter sets out what I hope is the general attitude towards this contest. "The Ross Hull Contest is held to commemorate the name of a great Australian amateur who was an individualist so the aim of the contest is to reward individual effort for the advancement of the art in the VHF/UHF spectrum — to this end the scoring table set out by Bob is a fair thing for the effort required and conditions that prevail on 6 m during the Ross Hull contest. I do not necessarily agree with the reasons that have been submitted as to why the change in scoring should take place but like in horse racing, now and again the handicaps are corrected so that all may have a fair chance at the stakes. I enjoy the contest and enter into the spirit of things chasing everything that makes a noise so I may be biased, but whatever the final rules for the 1974/5 Ross Hull contest, I will be there trying and hope this will give you some assistance and guidance for the final outcome of your dilemma. P.S. QRX 6m To hell with TV . . .

1974 B.A.R.T.G. CONTEST RESULTS

G8CDW, the BARTG Contests and Awards Manager, has kindly sent forward details of their RTTY contest which was won by SM4CMG notching 215080 points from 178 contacts to 39 countries on all bands except 10m. The first Australian participant was VK3KF 40th on the list with 40620 points followed by VK5IF 45th with 39016 points. No other VK appears in the 97 participants and there seemed to be only a lone PY to make up the total Southern Hemisphere contestants of 3 stations. ●

Book Review

TEST EQUIPMENT FOR THE RADIO AMATEUR.
H. L. Gibson, C.Eng, MIEE, G6CGA.

Every now and again a book appears which so completely meets the needs of its readers that the old cliche, "Should be in the Library of every licensed Amateur", is a valid remark. To sum up one's feelings about such a book in a few words is difficult and I am sure I cannot better the remarks of the author who says in his introduction "There are measurements which must be made in every amateur station, so a certain amount of test equipment is essential. This may be limited to relatively simple items in order to satisfy the licence conditions, but if equipment is to be home-constructed on any scale, the range of desirable instruments grows considerably. This book describes a range of test instruments and measurement methods sufficient for most stations operating in the hf and vhf bands. It includes both simple instruments and those using the latest techniques so far as they are reasonably economic".

Publisher: Radio Society of Great Britain.
Available from Advertising bookshops.

VK3ASC

Magazine Index

With Syd Clark, VK3ASC

BREAK-IN May 1974
Ideas for Building Transceivers; The Merits of AM v SSB; A Magnificent Rig in a Flying Machine. The NZART Callbook has also come to hand.

RADIO COMMUNICATION May 1974
Practical 10 GHz Gunn Oscillators, Downward Modulation and Business Mobile Transmitters; Loop Aerials Close to Ground; A Transistor Linear Amplifier for 160 M Mobile; Building Blocks for the Novice and usual features.

SHORTWAVE MAGAZINE May 1974
Traps for a Dipole; Fabricating B7A Valve Holders; Transistor Test Unit.

RADIO ZS April 1974
Erosion of Soldering Iron Bits; A VFO for 5-5.5 MHz; Medium Current Polarity Invertor; How to Solve Transistor Heatsink Problems.

May 1974
An SL600 Series SSB Transceiver; A Sample Low-pass Filter for Audio; Aluminium Soldering.

CQ April 1974
A Solid State Scaler for Frequency Counters, A Coax Fed Trio for 160, 80, 40 and You, Antennas, (General discussion by W6SAI). A Surplus Story, A Sloping Quad for 80 Metres, A One-Chip Two Tone Generator; Simple Super-Regulated 12 Volt Supply; CQ-75.

QST May 1974
Instant Oscar 6 Locator; A Satellite Timing Mechanism; CB Reformed — To 160; The SSB Crud-o-ject; The VE3GSD Transceiver, A Tone Beep Keyer for Repeaters, Learning to Work with Semiconductors, Part 2.

June 1974
Putting the G Line to Work; A Directional Indicator for the Hy-Gain Model 400 Rotor; More Receiver Design Notes, Part 1; A Tuning Control for Digital Frequency Synthesisers, A Hybrid Gate-Dip Oscillator; A High Power SCR Inverter; Learning to Work with Semiconductors, Part 3.

HAM RADIO February 1974
Solid State Transmitting Converter for 144 MHz; Digital Capacitance Meter (and 20 MHz Frequency Counter), How to Design L-Networks, RTTY Message Generator; Universal Frequency Standard; 455 kHz i.f Alignment Signal Generator; Multi-Channel FM Receiver for Six and Two

March 1974
Simple SSB Transmitter and Receiver for 40 metres; Automatically Controlled Access to Open Repeaters; Six Metre Frequency Synthesiser; Performance Characteristics of Vertical Antennas; Lowpass Filters for Solid-State Linear Amplifiers, Simple Digital Readout System; New FET's Simplify Bias Problems.

April 1974
Communications Techniques for Oscar 7; Simple Active Filters, Telefax Transceiver Conversion; The Argomate; Low Cost Receivers for Two-Metre FM; Broadband Amplifier; Nonresonant Antenna Impedance Measurements; Vertical Antenna Radiation Patterns, CW Regenerator.

73 MAGAZINE April 1974
A Delayed VOX for Repeaters, The FM "Auto-Start", The New Breed on 2 Metre FM; A Black Box Frequency Converter; How to Make the How-To's Work; A Two Metre Hybridised Transmitting Converter; Operating from a Sauna Bath, Control Panel for Your Scanning Transceiver; A CBer's Glossary of Amateur Terminology; Rock Solid Sub-Audible Tone Generator.

May 1974
Adding dBs to the Audio Compressor; Finding a New Home for the Mobile Rig, Interference Suppression for Amateur Boat Owners; Heath HW-202, A Simple Mobile Alarm System; Reducing Mobile Noise; The Newtronics CGT-144 Antenna, Another Burglar Alarm; Two High-gain RF Stages in One IC for Two Metre FM; An Oscar Special Converter; Toothpaste in the Ham Shack; Toward Mobile Security; Improving the Pearce-Simpson, Gladding 25; Putting Yourself on TV. ●

Awards Column

with BRIAN AUSTIN VK5CA
P.O. Box 7A, Crafers, SA, 5152.

GOLD COAST AWARD

A Certificate will be awarded to any amateur station or shortwave listener on receipt of their Standard Logsheet by the Awards Manager of the Gold Coast Radio Club, P.O. Box 588, Southport, Queensland 4215 listing contacts with FIVE member stations of the Gold Coast Radio Club and ONE additional contact with the Office Club Station, VK4WIG A list of member stations will be forwarded on receipt of a s.a.e. by the Awards Manager of the Gold Coast Radio Club

LIST OF MEMBERS OF DXCC AS AT 31.7.74

First number denotes Current Countries, second figure denotes Total Including Deletions.

PHONE			
VK6RU	315/347	VK4UC	286/293
VK4KS	314/333	VK4FJ	287/314
VK5MS	313/343	VK3JW	283/290
VK3AHO	304/326	VK4TY	279/288
VK6MK	302/329	VK2AAK	272/279
VK2APK	300/313	VK3ACD	266/274
VK4VX	300/304	VK2AHH	265/280
VK4PX	294/301	VK3TL	264/277
VK5AB	291/314	VK2SG	263/269
		VK4RF	254/259

VK4DO	244/261	VK4NQ	120/124
VK3AMK	239/243	VK4LZ	119/123
VK4CZ	238/242	VK3IP	118/122
VK3VK	234/238	VK3BBA	117/121
VK3HL	228/240	VK6DR	115/118
VK7DK	227/231	VK3APU	110/114
VK3JF	225/230	VK2ZA	109/112
VK6LK	213/218	VK3BCY	108/110
VK3SM	203/210	C21AA	108/113
VK3ALM	200/204	VK2AEB	103/108
VK3TG	198/205	VK3LC	103/107
VK4MY	198/202	VK5QI	103/106
VK3XM	196/201	VK5ZB	103/107
VK4XJ	192/200	VK6HE	102/104
VK5BB	188/193	VK8KP	102/106
VK6WV	187/192	VK9WD	102/106
VK7LZ	173/184	VK3XD	101/104
VK4FH	161/172	VK4ZK/9	101/104
VK3ZD	152/156	VK3SO	100/104
VK4PJ	150/153	VK4JS	100/102
VK1VP	148/152	VK5QB	100/103
VK3SX	143/146	VK6WY	100/103
VK3JM	139/143	VK2AXI	99/103
VK8CW	139/142	VK2GV	99/102
VK2AGO	137/142	VK3ADO	99/102
VK6KK	134/138	VK3AKZ	99/105
VK4SD	127/130	VK3OR	99/102
VK7JV	127/130	VK2KK	98/101
VK4QA	126/130	VK3CR	98/101
VK3QV	125/127	VK3WW	98/101
VK3ZY	121/125	VK2NM	97/100
VK6TW	121/123	VK2AMU	96/103

C.W.

VK3AHQ	308/331	VK4DO	196/218
VK2QL	299/326	VK4SD	187/206
VK3YL	292/316	VK4UC	171/177
VK2APK	291/304	VK5BO	163/181
VK4FJ	290/322	VK3AX	149/162
VK3XB	280/300	VK4MY	147/152
VK3NC	268/297	VK4XJ	147/157
VK4VX	263/268	VK2CK	142/146
VK6RU	262/291	VK2BG	139/146
VK3YD	258/281	VK2AHH	137/160
VK4TY	253/272	VK4KS	129/138
VK3TL	248/260	VK3SR	127/133
VK3RJ	248/265	VK3LV	122/126
VK3KS	243/254	VK3HL	116/121
VK4KX	234/239	VK5XK	114/122
VK4RF	231/252	VK4PX	104/112
VK7LZ	203/229	VK2GR	101/105
VK3AXK	200/218	VK4FH	98/105
VK3JF	199/210	VK6HA	97/101

OPEN

VK4KS	315/339	VK3QV	141/145
VK6RU	315/345	VK4NQ	132/136
VK4SD	314/335	VK3LV	127/131
VK2APK	311/329	VK5QI	127/130
VK2VN	311/336	VK9LV/G5RV	127/140
VK2EO	306/335	VK2AXK	125/132
VK4VX	306/312	VK6JK	125/136
VK6MK	302/329	VK6TW	125/127
VK4PX	301/312	VK4LZ	120/124
VK4FJ	300/332	VK8KP	116/121
VK4TY	300/321	VK3APU	112/116
VK2BG	299/309	VK4DV	111/115
VK4UC	297/303	VK9TB	110/114
VK3XB	286/306	VK3ABA	108/115
VK3TL	280/293	VK3YS	107/121
VK2AHH	273/292	VK6AI	107/110
VK4RF	273/290	VK3AXQ	106/110
VK3NC	269/298	VK4EZ	106/110
VK3ACD	266/275	VK5EJ	105/108
VK3JA	262/289	VK5FY	105/112
VK3JF	256/266	VK3OG	104/107
VK4DO	255/279	VK3SO	104/108
VK3HL	253/266	VK3XD	104/107
VK4KX	236/243	VK6BA	101/104
VK7LZ	233/259	VK2PA	100/112
VK4XJ	223/234	VK1QL	98/101
VK4MY	221/226	VK2AND	98/102
VK6HD	186/191	VK2PF	98/103
VK4FH	183/196	VK8ZZ	98/100
VK3SX	151/157	VK4JI	97/100
VK3HE	148/153	VK4QF	96/100
VK6KK	145/151	VK5EF	95/100
		VK3ACS	93/101

Where two stations have the same Current Countries total, the position in the above list is decided by numerical and alphabetical order of the call-sign.

The above list does not include a number of members in whose tally there has been no movement for a number of years. ●

W.I.A. (W.A. Div.)

RAFFLE RESULT

1st Prize — YAESU TRANSCEIVER
VK2ZZV, G. O'Brien, N.S.W.

2nd Prize — $60
C. Harper, Balga Balga, W.A.

3rd Prize — Typewriter
VK6EB, F. L. Bradshaw

4th Prize — $30
A. Pike, Alfred Cove, W.A.

5th Prize — $25
Morley, Cannington, W.A.

6th Prize — $25
VK6KY, A. M. Keighiley

7th Prize — $25
D. Patchin, Como, W.A.

8th Prize — Steam Iron
VK6ZK, T. Stanicic

9th Prize — $20
J. Kitney, Donnybrook, W.A.

10th Prize — $15
VK7TE, W. Tanner

Letters to the Editor

Any opinion expressed under this heading is the individual opinion of the writer and does not necessarily coincide with that of the Publishers.

The Editor,
Dear Sir,

After the discussion in previous ARs, some may be tempted to try (or be put off trying) direct conversion sets. The following has been based on my experience with this type of receiver, and my remarks should be viewed in the context of VHF and UHF receivers where noise figure (NF) is a meaningful figure of merit.

Low-noise audio amplifiers without transformer impedance matching to 50 ohms have about —70 dBm noise level. Thus a system using a mixer with about 5 dB conversion loss directly following the antenna will have a NF of 5 plus 5 plus (130 — 70) equals 70 dB since a 10 kHz bandwidth 5 dB NF system has a noise level of about —130 dBm. Thus gain of 70 dB is required at the signal frequency to attain adequate noise figure. This is not difficult if the stages do not require tuning — though cross-modulation may rear its ugly head.

The direct conversion receiver's real difficulty comes at this stage. The inevitable LO feedthrough caused by imperfectly balanced modulators, and by LO pickup in the front-end, gives a DC signal on the demodulated output. Variations in LO level (due to vibration or power supply) are resolved as audio output, and regeneration is virtually assured unless headphones are used. Even then, microphones are troublesome.

Thus high performance direct conversion receivers are "not on". Similarly, any stage which product detects to give audio must be balanced to minimise microphonics. 40-50 dB of LO suppression should be found adequate.

Chris Horwitz,
81 Prospect Rd., Summer Hill, N.S.W., 2130

The Editor,
Dear Sir,

There is no effective legal provision in Australia for the regulation of radiated, induced or conducted electromagnetic energy from sources other than licensed wireless transmitters, but it must be stated many utilities who are responsible for unavoidable noise-producing equipment do try and co-operate when advised by the PMG's department. The provisions of the Wireless Telegraphy Act and the Broadcast and Television Act control the licensing and conditions of operation of radio communication services in this country. It is difficult to comprehend that statutory powers exist which are binding on licensed operators of radio equipment but which do not apply to operators of equipment or machinery that cause pollution to the R spectrum in Australia, as in the USA and the UK commercial radio transmitters and associated equipment are 'type approved' and are licensed subject to the most stringent, almost state-of-the art specifications. Industrial and medical users can run RF oscillators or diathermy units, with a power of up to several kilowatts. These may be constructed with the absolute minimum of parts, little or no filtering, and can radiate interference for many miles, sometimes thousands of miles. The same with vehicle generated Electromagnetic Interference. It was stated (1) at the 1971 IREE workshop meeting (2) on radio interference "It is very evident that the need for a statutory authority exists with the power to lay down standards for the control of unnecessary emissions of noise with at least equivalent standards as are applied to the licensed users of the spectrum". Not only must the emission of 'noise' be reduced, the immunity of appliances and equipment must be increased by regulation. The general attitude of the manufacturers is that until we have approved technical performance standards for equipment, with each installation subject to approval and inspection by a government authority (3) no one manufacturer can afford design improvements. We must start treating industrial and commercial radio frequency equipment on the same basis as any other licensed communication service, or we must suffer a steady increasing amount of interference which seems likely to threaten each one of us and other com-

munication services.

In New Zealand it is now a statutory obligation for manufacturers of electrical equipment to limit radiation and interference from their equipment to within certain limits, and a user obligation to do likewise in the event of complaints.

Prevention is better than a cure. In 1934 an 'Internation Co-operation in the Suppression of Radio Interference' committee was formed called CISPR (4) who have laid down well defined limits as a standard.

Although air pollution is drawing more attention nowadays, prevention of pollution of the other end of the power supply systems is just as important in a world that will use more and more electric and electromagnetic energy for domestic and industrial purposes. Not all manufacturers, importers, and users of radio and electrical equipment in the past in Australia have exhibited a social conscience. Rules should be made to cover unapproved type or unlicensed radio transmitters, transceivers, and walkie-talkies entering the country by the thousands, and sold to innocent, and not so innocent unlicensed owners or operators.

Why is there this anomaly in regulations, allowed by the government? Earlier this year, responsible amateurs at Federal Level at the 1974 Federal Convention held in Sydney over Easter moved that the PMG be asked to consider the introduction of legislation to require purchasers of radio transmitters to produce evidence that they have a licence for the transmitter.

Let's hope this motion will prove just as successful as the recent WIA Submission to the Independent Enquiry into FM Broadcasting by the VHF/UHF Advisory Committee.

W. George Francis, VK3ASV

(1) See Page 26, Australian Electronics Engineering.

(2) "Second workshop on Radio Interference", March 1971, by Mr. M. Russell-Clarke, of the CFA.

(3) Electromagnetic interference caused by industrial users of RF generators by MONDEL, page 280, Proceedings IREE Australia, August 1970.

(4) CISPR — Comite International Special des Perturbations Radiophoniques.

The Editor,
Dear Sir,

On Sunday, December 1, 1974, between 6 am and 4 pm Queensland time (no daylight saving), the Brisbane VHF group will hold another field day for its members. In the past when field days have been held around this time of year, it has so happened that other clubs in other parts of Australia have also had field days at the same time. This has resulted in many more contacts for stations in the field, particularly on 6m, and has brought about some real competition. Might I suggest every club in Australia thinking about a field day around this time choose December 1 this year.

Organisers could consider offering more points for channel 50 operation than channel 40, perhaps double points for 432 MHz and up contacts, distance multipliers to be changed to kilometres from miles, and writing to local Channel 0 stations well in advance to seek their co-operation in not coming on the air until 15 minutes before programme time.

A note to me from each club running a field day that day could help our members pointing beams from their favourite mountain tops.

D. I. Marshall, VK4ZAF

The Editor,
Dear Sir,

Under the heading of equipment reviews could someone write up some of these portable 240V AC generators currently available?

I have heard that some perform well with a steady load but can't handle TX/RX type operation. Also it is said that frequency control of some is quite difficult.

As these units could open up new fields of portable and public service operation, what is the chance of getting some of our members with special skills to test a few of them.

Mike, VK3WW

(Any takers? — Ed.)

Editor,
Dear Sir,

As one who is foolish enough to remain in the WIA in the hope that justice may some day prevail, may I express my disgust at the continuing victimisation of the Associate member by the Victorian Division.

While not wishing to dispute the relative cheapness of the $17.00 proposed for Associate membership from June, 1974, what I do dispute is the meanness of this sum to the $17.50 required of a full member.

In 1970 the Associate paid the already unrealistically exorbitant figure of 94 per cent of full membership. In 1972 we saw 95 per cent and in 1973 up to 96 per cent. Now we have 97 per cent — and in three years, undoubtedly, the decimal places of 99 per cent.

As justification for the high figure the unbiased council (of full members) reminds one that both amateurs and associates receive the benefits of AR (how much associate based content?), must pay the Federal Levy, the IRU levy, and help subsidise that complexity of three legged fuses which has trouble alloting and collating short wave listeners numbers (but manages to generate accounts). Thus the gap is larger than it seems, so we are told.

On the other side what about the no voting rights for associates, no call book listings, no new member listing in AR, and a low priority for disposals equipment (despite the protests that no bias exists). In other words why should a 3 per cent difference entitle the full member to the extra benefits. (And please don't ask why we therefore don't become full members — some of us are happy just to listen and should be entitled to do so at a reasonable membership cost).

So Victorian full members — be proud of your Council and please, accept our subsidy towards your subscriptions.

P.S.—This is not a stab in the back to the Victorian Executive — they were advised of my feelings in July, 1973 after I discontinued attending the monthly executive meetings.

Brian J. Hannan, WIA L3185
Lot 64, Heroes Avenue,
Emerald, Vic. 3782

FM and 2 m REPEATER DETAILS

The ever-busy George Francis, VK3ASV has sent in a wealth of information (regrettably too much to print . . . Ed.) on his researches into 2 metre channels for his directory.

The details now given are mainly from his material with other data obtained from various sources subsequent to the date of his letter. For channel frequencies see March 1974 AR, page 23.

VK1 Considerable activity going ahead to build their 46/58 repeater.

VK2 (a) Sydney repeater VK2RAS (R1) on **old** Ch 4 and located at Hornsby (Dural) with 5 minute auto ID. Repeater officer VK2ZPJ.
(b) Hunter river area repeater VK2RAN (R2) on **old** Ch 4; located on Mt. Sugarloaf 96 km North of Sydney. Repeater officer VK2BSC.
(c) Central Coast repeater VK2RAG (previously VK2AFR/R) on **old** Ch 1. Located at club rooms Karlong 6 km SW of Gosford. Ident on MCW. Repeater rx operates continuously. If repeater tx is not heard send steady unbroken flutter free carrier for 5 secs. then wait 40 secs. for tx valve filaments to warm up. Tune up signal facilities available. Auto change-over emergency power supplies. Normally allow ½ sec. for relays to operate before speaking. Auto ID F2 860 Hz. Repeater group VK2ZRQ, VK2ZUX.
(d) Orange and District repeater VK2RAO (ex VK2AOA/R) on Mt. Canobolas 146.1 MHz input 145.854 MHz out. Known as "FRED" (Frequently Ridiculous Electronic Device) and first (experimental) repeater in VK. Range up to 160 km. Repeater officer VK2ZKN.
(e) Illawarra repeater (ex VK2AMW/R) on **old** Ch 1 located (temporarily at Figtree) at Mt. Robertson. 10W o/p. CW ident every 5 mins. Workable from Sydney southwards. Repeater officers VK2AGV; VK2BHY.
(f) Mt. Kaputar. Ch 46/58.

VK3 (a) Melbourne repeater VK3WI/R1 on Mt. Dandenong Ch 42/54. 60W o/p. 120 km useful mobile to mobile service area. Verbal ident. Chairman Repeater Committee VK3BX.
(b) Geelong repeater VK3RAG on Mt. Anakie 18 km NNW Geelong. Ch 48/60 25W o/p. 6 min. timer verbal ident. 65 km range. Repeater officer VK3AQR.
(c) Latrobe Valley repeater VK3RAB on Mt. Tassie. 12W o/p Ch 44/54. 160 km range verbal ident. Repeater officer VK3QZ.
(d) Greater Bendigo area repeater VK3RAM (Midland Zone) on Flora Hill (to shift to Mt. Alexandra) Ch 44/54. 10W o/p. 5 min lock-out. Auto ID FSK. Repeater Gp VK3AAA, VK3ACT, VK3ZKV.
(e) Projected repeaters on Mt. William Ch 42/54, Mt. Macedon Ch 46/58 and Mildura Ch 48/60.

VK4 (a) Gold Coast repeater VK4EI/R2 on Mt. Tambourine, 60 km SW of Brisbane, proposed Ch 42/54. 25W o/p. Repeater Gp VK4ZDA, VK4ZFD.
(b) Ipswich projected repeater on Denmark Hill Ch 46/58.
(c) Northern Brisbane repeater project, perhaps on Mt. Cootha Ch 48/60.
(d) Projected Townsville repeater Ch 42/54.

VK5 Adelaide repeater VK5RAD (ex VK5WI/RI) at Crafers near Mt. Lofty. Ch 48/60. 15W o/p MCW auto ident. 5½ min lock-out. Range 80 km mobiles WICEN priority. Repeater Gp VK5ZK, VK5WB. See AR April/May 1972.

VK6 (a) Perth repeater VK6RAP on Tuart Hill. Ch 42/54. CW ident. Range 160 km S, 80 km N. 50 km inland.
(b) Albany repeater on Mt. Barker 50 km N of Albany. Ch 44/54. Southern Electronics Gp.

VK7 (a) Mt. Barrow repeater (NE Tasmania) Ch 48/60 60W o/p. 13 wpm MCW ident. each 2½ min. Lock-out 5 min. Repeater officer VK7PF.
(b) Hobart repeater on Mt. Wellington. Ch 42/54.

(Due to the efflux of time some details may be dated by the time this is printed.—Ed.)

NOTHING NEW

The following extract from THE ELECTRICAL TRADER February 1933, has a very familar sound.

RADIO INDUCTIVE INTERFERENCE

In some Electricity Supply Undertakings a great deal of interference is experienced from the Electric Supply Mains and the various types of apparatus used in the system. This has been very marked in the recent broadcasts of the Test Cricket.

Interference may arise from a large and varied number of causes. It is an inherent fault in many of the older types of apparatus and systems of supply, in fact, it may be said to be inseparable from these systems.

At the Local Government Association Conference held last month the subject was discussed and the suggestion that the responsibility for interference of this kind should be determined by an Act of Parliament was mooted.

While engineers know quite a lot about the causes of interference from inductive sources, there are still quite a lot that is not known about it and it is manifestly impossible for regulation by law.

In a great many cases the system of supply must be entirely revolutionised if inductive interference with radio apparatus is to be eliminated while in others the fault lies in consumers' apparatus and not in the supply system.

Radio Engineers are working in conjunction with supply engineers to track down the trouble and great progress is being made in this way. Much benefit has resulted to the public supply undertaking from this co-operation, because the interference has shown up faults, which would have cost the undertaking a lot of money, that otherwise would have gone undetected for a considerable time.

The Department which deals with Interference is that branch of the PMG's Department, the Radio Inspector's branch. Any fault or interruption to radio reception should be reported to this department and the trouble will be tracked down.

In some towns local listeners-in have banded together to overcome the trouble and in Lismore there is a "Listeners' League", which has done good work and removed a lot of worry from the shoulders of the local Electrical Engineer and the Radio Inspector's Department, at the same time ensuring for themselves better reception.

The subject of Radio Inductive Interference is down for discussion by Electricity Supply Engineers at their forthcoming Annual Conference in March next. This will form a cross discussion between supply engineers and radio engineers of the Radio Institution. Mr. W. T. Crawford, Radio Inspector, will, it is hoped, also be present.

More good will come from discussions of this kind than from the framing of new legislation which while, perhaps, conferring a benefit on one section will hamper the development of a growing industry. ●

Hamads

FOR SALE

Chart Recorder 3 channel (2 plus timing channel), 5 speeds, 4 inch wide tape, $80. **SYNC Generator,** Marconi BD637D, $40. VK2ZTY, QTHR. Ph.: (02) 30 4312.

FT200, 4 months old, sell $370 or trade in on FT401, similar condition. VK4IJ, ex VK4ZHM, QTHR. Ph.: (072) 56 2610.

Colour TV, brand new, all solid-state, 18 in. PAL-D. Tunes VHF and UHF (including 430 MHz.) $600. David VK2ZZJ. Ph.: (02) 44 3036.

57 ft. Hills Crank-up Tower. 12 months old, as new, $120. G. Stern, c/- P.O. Box 330, Hurstville, 2220.

AWA Carphones FM TX and RX 70-85 MHz with power supplies. Some cables and Handsets. $15 as they come or offer. See L. D. Sykes, 6 Somme Parade, Edithvale, 3196. Disabled Radio Amateurs' Club, VK3ZZ.

COSSOR pulse oscillograph, Model 1065, 15 MHz bandwidth, complete with handbook and two CRO tubes, both faulty, $55. Small **tape recorder,** ideal for Morse practice and specially adapted for this purpose. Complete with key, oscillator, professionally recorded tapes and earphone, $15. VK3AOH, QTHR.

Hivico 4DD-6 Discrete 4 channel Demodulator, 6 ICs, 6 FETs, 27 transistors. New, complete with manual and test record. $95 or offer. Colin Baldock, VK3ZEF, 71 Enfield Ave., Park Orchards, 3114. Ph.: (03) 870 3967 after 19.00h.

Signal Generator, Marconi TF801A 10-300 MHz, calibrated output, $160. **R. & S.** VHF Voltmeter, $20. VK3YAZ, QTHR. Ph.: (03) 25 2680.

Yaesu FTdx 560 transceiver, excellent condition, with Yaesu SP-560 matching speaker, manual, set spare 6KD6s, $425. VK4UG, QTHR. Ph.: (072) 84 6096.

HW 32A Heathkit 20 M. SSB Transceiver with HRA-10-1 100 KHz Calibrator and Turner 350C MIC. Extra switched x-tal to tune to 14.05. Home brew mains supply. Also 12 volt mobile supply with in-built 50 ohm forward and reverse meters. L-Match 20 M. base loading coil for 12 foot whip, $170 the lot. **Bendix Freq. Meter** LM-7 with 240V supply, $30, **Prop. Pitch Meter,** $30. Ring Ted VK3XT (03) 560 5051 evenings.

AR7, all coil boxes, AC/DC P/S, speaker, alignment instructions, spare tubes, $60. Also **Pye Mk III** Reporter with x-tals 53.032 MHz, transistor P/S, spare final tubes, $30. **Pyrex** Tape Recorder 7 inch reel 7½ I.P.S. $10. **Command** TX BC-459 inc. spare tubes, $10. VK3ZPN, QTHR.

80W AM/CW TX. 160M to 10M. Geloso VFO. 807 final 6L6's mod. Complete, $25. VK3CV. Ph.: (03) 82 6431. QTHR.

Pye 734 Solid State 25 Watt FM Transceiver, converted for 2 metres, includes: x-tals for repeaters 1 and 4 also 146.00 Megs, Cradle and Mike. $125. Ring 467 2131 bus. hours. VK3YBE/T. **Pye** ranger **FM** carphone, converted to 2m. Transistor power supply, 3/12 output. Complete with x-tals, fet preamp, 5/8 whip and circuits. I think it still works, $25 or exchange for handful of 40/80m rocks for my type 3 mk 2, or combination of above. VK3AQQ, 5 Duncan St., Box Hill. Ph.: (03) 288 4324 (A.H.).

62 Transceiver, 2-10 Megs., 5 Watt output, set contains 12 Volt DC-DC convertor, $55. VK3EB, QTHR. Ph.: (03) 82-1769.

2m TCA1677 Transceiver, fully converted, mint condition, with x-tals for Ch B, 4 and X, complete with manual. Price $130 or offer. **Electronic Keyer** with power supply. RF stage (3 tubes) to cover the whole of the 2 m band, with power supply. What offers? VK2BJK, QTHR. Ph.: (02) 449-1598.

Superior VHF QTH C/W House, Shack and Workshop, also XYL sized lawns, 12 km south of Adelaide. Available late November, 1974. Enquiries VK5ZWW, Box 1117. Orange 2800.

Silent Keys

VK2EH Mr. E. P. HODGKINS

TED CHANDLER VK4EJ

The members of the Townsville Amateur Radio Club paid a final tribute to Ted VK4EJ on Thursday 13th June, 1974. Ted, a foundation member of the Club and a pioneer of radio in North Queensland will be remembered by many old timers for his distinctive "fist" on either key or bug.

When Ted finally came on phone on a homebrew SSB rig, he regularly made his presence felt on the "Meatworks Net".

A great number of people were started off in pursuit of electronics by Ted, and a number continued on to make their career in this field.

Ted will be sorely missed, both on the Amateur Bands, and by his friends in Townsville.

QSP

IARU REGION 3 CONFERENCE

The W.I.A. has received notice that the next IARU Region 3 Association Conference will be held in Hong Kong from 4th to 13th March 1975. The theme of this Conference will be the World Administrative Radio Conference, Geneva 1979 and member societies have been asked to submit Agenda items as early as possible.

AERIALS, TREES, DRAIN-PIPES, ETC.

"Fat, heavy people, it is claimed, are better aerials than slim, small ones! Generally the efficiency of the body corresponds to that of a matched, centre loaded whip 1.2m long at 4.2 MHz. Apparently you cannot couple a transmitter to the belly but only to 'other parts of the body'." From Pat Hawker's Technical Topics in Rad. Communications, April '74. Match that one!

AMATEUR SATELLITES

"William Eitel WA7LRU/W6UF and Herbert Hoover III W8APW have generously offered to match, dollar-for-dollar, up to a total of $25,000, donations to the ARRL Foundation earmarked for use in the Amateur satellite programme. Funds are urgently needed to support the construction of AMSAT-OSCAR 8 which is estimated will cost on the order of $100,000. The ARRL Foundation Inc., 225 Main Street, Newington, Conn. 06111 U.S.A. Extracts from AMSAT Newsletter, June 1974.

SATELLITE 1000 AWARD

IARU Region 1 News for April '74 lists 165 winners of the Satellite 1000 Award at 22.1.74. The list includes 2 VK7s and 1 VK5, no ZLs, no ZSs or indeed anyone from Africa except ZE7JX. Most interesting though was the listing of 16 JA stations, VU2UY and a 4X4 in the whole of Asia. In the Pacific Area DU1FJ and DU1POL are listed as well as KX6HK and 4 KH6s. Almost the whole of the remainder were Ws or Europeans. Brief details of the Satellite 1000 Award were listed on page 71 of July '73 AR. ●

WANTED

Incomplete MTR13, and pin connections and data on an EG-851 cathode ray tube. John Lancaster, VK3ZCX. Ph.: (03) 62 0201 ext. 2486 B.H. or 89 9017 A.H.

455 kHz Mechanical Filters, AM, SSB or CW bandwidths, with or without carrier crystals; prices and specifications to Bill Roper, VK3ARZ, 12 Explorers Court, Vermont South, 3133.

Selsun Receiver or pair of Selsuns. Details to VK6LT, 19 Errinbee St., Riverton, W.A. 6155.

Circuit Diagrams and tuning data on ATR2C RAAF Transceiver and also Power Supply K1 to suit ATR2C. Contact Col Paton, 2 Premier St., Maryborough, Qld. 4650.

TH3 Jr (or similar) and Rotator. Melb. Uni. Radio Club. VK3ATM, QTHR. Ph.: Sec. (03) 47 5968 A.H.

Loan or buy Inst. Book or Diagram RAAF sig. gen. TA101C. VK2AJ, QTHR or ph.: (02) 579 5716.

Two Metre Mobile Transceiver wanted by new amateur. Details to Ph. (03) 328 4148.

RX General Coverage or Amateur Bands. Miniature tubes. Star, etc. VK3 preferred. A. L. Mac Farlane, Lardner Rd., Warragul, Vic. 3820.

For More Efficient...
TRANSMISSION and RECEPTION install a

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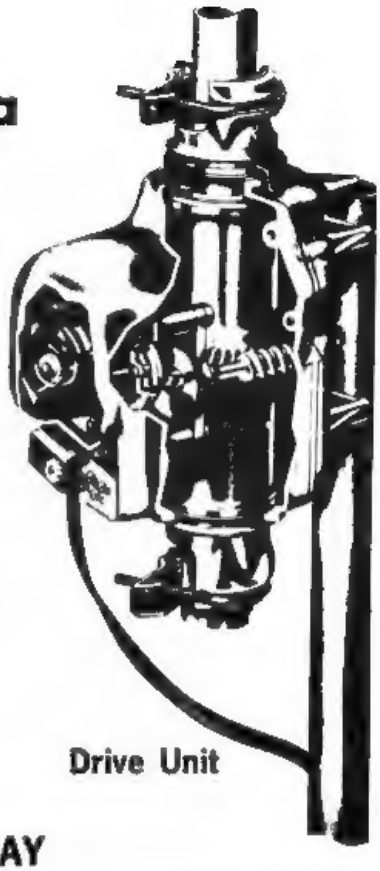
Now with powerful thrust bearing for greater strength and load capacity.

An unrivalled aerial rotating system for TV or Amateur Radio antennas. With a **STOLLE Automatic Aerial Rotator,** accurate and positive antenna positioning in any direction, is right at your fingertips. This allows you to beam your antenna (for transmission or reception) by simply turning the control knob to the desired position, with a full 360° coverage. A STOLLE rotator is rugged enough to handle the weight and wind load requirements of ham antennas up to the size of a normal 3-element 20-metre beam. It can operate for sustained periods of time without thermal overload . . . and with absolute synchronization. Positive disc brake on motor prevents "overshoot".

A five-core cable is available to connect rotor to control unit.



Drive Unit

Control Unit

Install a STOLLE Rotator TODAY

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TP-8/74

YAESU FT-2FB
2M FM

The **FT-2FB** is a compact 12 channel 10W/1W, FM transceiver with squelch and volume controls, panel mounted. The **"S"** meter is output meter on transmit. Comes complete with built-in speaker, P.T.T. microphone, mobile mounting bracket, power cable and antenna connector. Orders now being taken for supply from current delivery. Price of the **FT-2FB** is **$198 including three Australian Channels (B, 1 & 4) installed. Tested, ready to use on 12V DC.**

Extra crystals available for other channels. A matching voltage regulated AC power supply, model **FP-2, $59,** incorporates battery charger and large built-in speaker.

Prices include S.T. Freight extra. Prices and specifications subject to change.

All sets pre-sales checked. 90 day warranty and continuing service available only from the Australian agent:—

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ELECTRONIC SERVICES

60 Shannon St. Box Hill North, Vic., 3129.
Ph. 89-2213

QLD	MITCHELL RADIO CO., 59 Albion Road, Albion, 4010	Ph. 57 6830
N.S.W.	STEPHEN KUHL, P.O. Box 56, Mascot, 2020	Ph. Day 667 1650 A.H. 371 5445
S.A.	FARMERS RADIO PTY. LTD., 257 Angas Street, Adelaide, 5000	Ph. 23 1268
W.A.	H. R. PFIDE, 26 Lockhart Street, Como, 6152	Ph. 60 4379